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# CANADIAN ATLANTIC FISHERIES SCIENTIFIC ADVISORY COMMITTEE (CAFSAC)

# ANNUAL REPORT

## (INCLUDING ADVISORY DOCUMENTS)

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# Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Annual Report Volume 13 1990

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# Section 1

## Report on Committee Activities

## Terms of Reference

## Canadian Atlantic Fisheries Scientific Advisory Committee

1. CAFSAC is responsible for providing scientific advice to the Atlantic Directors-General Committee on the management, including the full range of conservation measures taking into account economic objectives, of all stocks of interest or potential interest to Atlantic coast fishermen. Resource management advice will be provided in accordance with specific fisheries management objectives and strategies and will normally be published as a matter of routine.

2. CAFSAC is to serve as the Atlantic focus for development of fisheries resource management science through program development and scientific interchange. As a forum for the advancement of the fisheries management science, CAFSAC shall organize workshops and symposia on specific problem areas.

3. CAFSAC will serve as a forum to identify the requirements for the collection, from the fisheries, of biological and statistical data necessary for scientific evaluation of the stocks and for effective scientific monitoring on both domestic and foreign fisheries.

4. CAFSAC will endeavour to ensure liaison with other committees or subcommittees established by the Atlantic Directors-General Committee. Such liaison will include mutual referral and it will also include joint meetings with other fora of consultation so as to ensure advice arising from the various lines is as compatible as possible and is consistent with long-term objectives for Atlantic fisheries.

5. In relation to the above functions, CAFSAC will review research priorities and performance in the Atlantic regions and shall advise the Atlantic Science Directors when changes in priorities, program objectives, or resources appear warranted.

## Chairperson's Summary

The extension of multi-year fisheries management plans to groundfish, after its introduction for salmon in 1984 and for shrimp in 1989, is one of the major events of the 1990 fisheries management scene. It introduces an element of predictability in an industry that desperately needed some. The fishing industry has sufficient difficulty in trying to cope with the unpredictability of nature and that of market demand, without having to contend with the unpredictability of scientific advice.

The provision of advice in the context of multi-year fisheries management plans is a challenge for CAFSAC members. The provision of yearly catch forecasts at a reference fishing mortality will be replaced by an evaluation of the consequences of the existing management plans on fishing mortality and stock size. This will lead to changes in the way we are doing business and may result in more robust and more useful advice by forcing us to concentrate on fisheries assessments instead of fish stocks assessments. It will therefore result in the scientific advice being less variable from year to year. It will force us to tackle directly the questions of the uncertainties of our advice and the risks associated with various management decisions. It may also eventually entice the fishing industry and fisheries managers to focus on the objectives of fisheries management rather than react to short term resource fluctuations.

Hopefully, the multi-year management plan framework will allow us to consider important aspects of our work that we have had to neglect because of the pressing demands of fisheries management for stock assessment information. Questions related to fish habitat (where the Anadromous, Catadromous, and Freshwater Fishes Subcommittee and the Marine Ecosystems and Environment Subcommittees have already made important steps) and the multispecies dimension of our advice, especially as it concerns the effect of seals on commercial fisheries and commercial fish stocks are among the main ones to address.

J.-J. Maguire

## Summary of Subcommittee Activities in 1990

The CAFSAC subcommittees held eighteen meetings in 1990 and the scientific advice provided is contained in Section II of this report. Other items considered are summarized briefly in the following pages. The subcommittees spent some time in discussions related to the provision and the format of advice, and the merits of multi-year advice for some stocks. While the process for groundfish became relatively well defined, this will be a subject of ongoing review in 1991. There were no issues identified for review by the Marine Mammals Subcommittee in 1990, therefore no meetings of that subcommittee occurred.

The **Anadromous, Catadromous and Freshwater Fishes Subcommittee** held three meetings in 1990. The salmon stocks considered at the February meeting were included in the 1989 advisory and those reviewed in the fall of 1990 are produced in the 1991 advisory. Memoranda to the ADMs were produced on the gaspereau and Arctic charr stocks and appear at the end of Section II of this report. The subcommittee also reviewed material on striped bass populations of the Scotia-Fundy Region (Res. Doc 90/36) and the Gulf of St. Lawrence (Res. Doc. 90/71). A special session of the subcommittee to address the usefulness of various attributes for measuring productive capacity of fish habitat related to salmonids in terms of the department's policy for the management of fish habitat was held in St. John's, Newfoundland in the spring of 1990. A total of twenty-one collected papers from this subcommittee meeting were compiled and produced as CAFSAC Res. Doc. 90/77.

Target spawning requirements for fluvial and lacustrine habitats were derived for selected river systems in insular Newfoundland. A value of 3 smolts/unit (a unit = 100 $m^2$) of fluvial parr rearing habitat was used to estimate smolt production. This value was established from counts of migrating smolts from North Harbour River and Bay du Nord River where juvenile rearing occurs almost exclusively in fluvial habitat. For lacustrine habitat, estimates for all rivers were examined and the values ranged from 2.0 smolts/ha in Western Arm Brook to 10.9 smolts/ha in Beaver River. Because of the limited amount of data available, there was difficulty in assigning values to Salmon Fishing Areas (SFAs) for which there was no information. Therefore, the average of all values (6 smolts/ha) was recommended for use in all areas. This value was changed after review in early 1991 and 7 smolts/ha was adopted as the value to be used in the absence of specific information. While these parameters were considered the best available, the subcommittee outlined various caveats relating to assigning average values and the parameters used in establishing them.

Recruitment variation in the salmon stocks in the inner Bay of Fundy was reviewed (Res. Doc. 90/41). The subcommittee recommended that: 1) monitoring of juvenile salmon be continued; 2) adult sampling for age composition be increased; 3) disease sampling of both juveniles and adults be continued; and 4) a controlled experiment to determine the impact of vibriosis be carried out.

The subcommittee reviewed a paper on the usefulness of the ratio of one-sea-winter to multi-sea-winter salmon as an index for assessing the impact of the 1984 management plan (Res. Doc. 90/69). This included a randomization test to analyse return data as an alternative to a multiplicative model. It was suggested that the conclusion that the management plan led to a significant improvement in survival of multi-sea-winter salmon was dependent on the assumption that the proportion of the original number of smolts that return as one-sea-winter fish remains constant and that the years immediately prior to the introduction of the plan are included in the analysis.

The subcommittee reviewed an application of a multiplicative model to examine effects of season, time period, and river characteristics to measure the relative differences in the one-sea-winter to multi-sea-winter ratios of salmon returning to the thirteen rivers in eastern Canada. The subcommittee made various recommendations for further refinement of this work.

In the context of deriving target spawning requirements for various SFAs, a discussion was held on the use of angling exploitation rates to estimate river escapements in relation to the target. This would apply to those systems where direct counts of fish are not available. Data available from several Newfoundland SFAs indicated more homogeneity of rates within SFAs than among SFAs and the subcommittee recommended that SFA-specific exploitation rates should be used where possible. The subcommittee also recommended that

regions review estimates of angling exploitation rates in more detail, and that information should be pooled among regions so analyses of larger data sets could be carried out.

Various questions relating to the Atlantic salmon stocks of Newfoundland and Labrador arose as a result of the Atlantic Salmon Workshop that had been held in Corner Brook, Newfoundland in November of 1989. These questions were reviewed by the subcommittee as possible input to the development of the 1990 management plan.

The subcommittee reviewed both parametric and non-parametric models for the Miramichi River salmon forecast. This review was prompted by the poor fit and performance of parametric regression forecasting models used in past assessments. Various recommendations were made and work in this area will continue in 1991.

An approach to provide in-season forecast advice on multi-sea-winter salmon in the Miramichi was reviewed. A practical application of this model might be in the use of the relationship between the in-season and pre-season confidence interval widths as indicators of the application of existing management plans based on pre-season forecasts. Additional analyses will determine the general applicability of this approach to the Miramichi River and recommendations were made by the subcommittee relating to the refinement of this work.

The model for forecasting multi-sea-winter salmon returns to the Saint John River, for fish produced above Mactaquac was reviewed and the results are presented in Res. Doc. 90/84. The subcommittee noted that the performance of the model should be monitored closely because of the multicollinearity between the two independent variables.

The subcommittee reviewed a simulation approach to investigate the usefulness of relationships between multi-sea-winter salmon in year i+1 and one-sea-winter salmon in year i to forecast multi-sea-winter salmon or to detect changes in processes such as survival at sea. Preliminary results indicated that the model was very sensitive to uncertainty and modifications were suggested.

A paper was presented related to recruitment predictions for gaspereau which compared predictions from an empirical, linear stock-recruitment relationship and those from a non-parametric probability density function (pdf) model of future returns from various escapements of alewife and blueback herring at the Mactaquac Dam, Saint John River. Both models predicted similar returns at each escapement level. The subcommittee noted however that the additional information presented by a pdf analysis can be of use in making management decisions.

As in previous years, the subcommittee reviewed papers prior to their submission to the spring meeting of the International Council for the Exploration of the Seas (ICES). The subject areas addressed included: harvest and exploitation rates for Saint John River salmon in homewater and distant fisheries; compilation of tag release data; ratios of coded-wire tags to adipose fin clips for Atlantic salmon; and updates on the 1989 Atlantic salmon catches at west Greenland. On the last subject, the subcommittee noted that the catch at Greenland in 1989 was about 60% less than the 900 t quota. The reasons for the decline in catch may be related to decreased effort because of the low price paid to fishermen and/or low abundance of salmon at Greenland because of the cold environmental conditions in 1989. The low catch, if related to abundance, may result in poor returns of multi-sea-winter salmon to Canadian rivers in 1990. In 1983 and 1984, the fishery at Greenland did not achieve its quota and subsequent returns to Canadian stocks were also lower than anticipated. Data for the first two weeks of the 1990 fishing season in west Greenland were low which suggested low abundance that may translate itself into low returns of two sea winter salmon to Canada in 1991.

**The Groundfish Subcommittee** met twice in 1990 and the advice provided on the groundfish stocks is contained in Ad. Doc. 90/5 and 90/8. Multi-year advice was implemented on most groundfish stocks in 1990. The subcommittee noted that while it is possible to achieve a constant catch level for a number of years, it will not result in the maintenance of a constant fishing mortality. Recruitment fisheries, that is those depending on

incoming recruitment, were considered not well suited for multi-year plans. The concept of risk analysis was investigated by the subcommittee to analyse the trade-off between the extended time frame of the advice and the risk of detrimental impacts on the stock or fishery. Preliminary analysis are reported in Res. Doc. 90/75 but work is ongoing in this area. Coupled with this initiative, was the introduction of regional reviews for some groundfish stocks. These reviews took place for the first time in 1990 in all the Atlantic regions and the results were included in the groundfish advisory document. The need for establishment of some guidelines concerning the scope, format, presentation and documentation of these reviews was highlighted and a working group was established early in 1991 to address these questions.

In addition to the stocks reviewed in the advisory, the subcommittees considered the implication of higher TACs for the haddock stocks in divisions 3LNO and 3Ps. For the 3LNO stock, the subcommittee recommended that there be no directed fishery and noted that the increased catches in recent years were possible because of a pulse of relatively good recruitment and increased fishing effort. However, if managers want to allow a sustainable haddock fishery to be established in the division, the development of a strategy to protect any future pulses of recruitment was suggested. These conclusions were considered applicable to 3Ps haddock as well.

Density-dependent growth and related subjects were reviewed extensively by the Groundfish Subcommittee in 1990. Mean size at age for eight Atlantic cod stocks was studied and it was concluded that size was negatively correlated with population abundance in five cases, consistent with the hypothesis of density-dependent growth. It was noted that the three stocks which did not present significant correlations with population abundance were at the southern end of the range and also had the fastest growth rate. Since analyses were conducted using mean size derived from research vessel surveys, the subcommittee concluded that changes in observed weights at age in the fishery are real and not an artifact of variation in the timing of the fishery or of changes in the proportion of catch by the various gears from year to year. The subcommittee concluded that in order for management actions to be appropriate, the mechanisms of density-dependent growth should be understood. Identifying the mechanisms causing changes in growth appears to be complex and other factors besides those investigated (that is, prey abundance, parasite load, and differential survival of larvae) may be important. It was agreed that further work is necessary and models which include effects of density on growth but not on recruitment and other processes should not be used to define biological reference points.

Mean weight versus density for various stocks was examined and it was noted that the smallest cod are found in Division 4TVn and these fish also have the highest numbers per tow. The largest cod are found in divisions 5Z and 4X, and these have the lowest mean catch per tow. Other stocks studied suggest a declining trend in weight in relation to density. Further investigation of these data for other ages and time periods was recommended.

The subcommittee also examined other studies in an attempt to relate cod growth to variables other than density. The influence of temperature on growth and size at age was examined for four cod stocks: 2J3KL, 3NO, 4X and 5Z-SA6. Significant correlations between mean size and temperature were found for cod in 2J3KL and 3NO. It was noted that the temperature series used should represent the overall temperature conditions experienced by the fish and have good spatial and temporal resolution.

An equation for growth that utilized environmental information to predict incremental yearly growth was presented (Res. Doc. 90/48). The effect of capelin biomass on cod growth was examined and it was noted that no effect of capelin biomass could be detected, although both cod biomass and temperature anomaly were highly statistically significant, leading to the interpretation that cod switch to other food sources when capelin are scarce. However, it was stressed that the relationship between capelin biomass and cod growth is complex and may be confounded by other factors such as temperature. Difficulties involved in estimating capelin biomass were noted as a factor that may be obscuring the relationship with cod growth.

Size at age in terms of length, weight and growth rates for 4TVn (January-April) cod obtained from research surveys were compared with two environmental variables: mean water run-off from the St. Lawrence and bottom temperatures observed in the September survey. Results indicated no significant correlation between size and mean run-off except when the dependent variable (size) was lagged by the age of the cohort. However, the relationships had negative slopes which is contrary to the hypothesis that increased nutrient entrainment has a positive effect on growth. Furthermore, when combined in a model including population size, mean run-off did not explain a significant portion of the variance. No significant correlations were found with bottom temperatures from the survey.

An analysis of the effect of size-selective fishing mortality on mean size for the 4TVn cod stock was presented. Results indicated that a significant portion of the fast-growing fish are taken by the fishery for ages 6-11 (mean 40.3%). This size-selective fishing mortality removes fast-growing cod disproportionately faster than slow-growing cod from the population at each age. This could have the effect of reducing average length at age for the various age classes since it takes longer for a fish to grow to a specific threshold. The subcommittee recommended that further analysis of size-selective fishing mortality be conducted using data from the seventies which was a period of high fishing mortality where the effect of size-selective mortality should be greater. In addition, it recommended that simulations of size-selective fishing mortality on average size be undertaken to demonstrate the mechanisms involved and their relative importance for temporal changes in mean length at age and mean weight at age.

The subcommittee concluded that where the data were available, environmental conditions explained little if any of the variation in cod growth. Stock biomass and population numbers remained the best explanatory variable for these stocks where the effect has been demonstrated. However, attempts to provide a mechanistic approach to density dependence such as those reported above have proven unsuccessful.

Two hypotheses were put forward to relate the effect of density on growth: 1) the continuous competition hypothesis where growth is affected by competition throughout the lifetime of a cohort; and 2) a bottleneck effect where the growth history is determined early on by the initial density of the cohort, this effect being amplified by size selective fishing mortality. Inclusion of density dependence of type 1 will have a serious impact on the current management of the fisheries and the reference level fishing mortality. Therefore, the subcommittee recommended: 1) that the hypothesis of density dependence be examined for contradictory evidence in order to ascertain that the correlation between density and size are not spurious; and 2) that the consequences of the two mechanisms postulated for density dependence be examined.

A length-based yield per recruit model with density-dependent growth was reviewed. Any amount of density dependence caused an increase in $F_{0.1}$ and yield at $F_{0.1}$ compared to the estimates from a stock having fixed, virgin population growth rates. With levels of density dependence which would cause changes in growth about one-half of those seen in Gulf cod stocks, the $F_{0.1}$ was estimated to be about 0.46 which may be compared to the current estimates of 0.2. If density-dependent growth can be demonstrated, it will be necessary to revise methods for determination of $F_{0.1}$ presuming that it remains the accepted target fishing mortality. The same would be true for stock-recruitment relationships. In light of this, the subcommittee suggested that a workshop be convened to review the implications of studies on density dependence, other changes observed in growth, and the definition of target fishing mortalities based on yield and recruitment models. The discussion should also consider the implications of these targets in relation to multi-year management plans.

The subcommittee reviewed the impact of quota transfers from the fixed-gear to mobile-gear sector for cod in Subdivision 3Pn and divisions 4RS. Calculations indicated that the long-term yield for the fishery decreased by about 20% as the proportion of mobile effort increased from 0 to 100%. More importantly, however, the results showed that fixed-gear yield decreased rapidly as the mobile-gear fishing effort increased. This decrease in fixed-gear catches was a result of the mobile sector catching younger fish than the fixed sector and, in fact, acting as an interception fishery. Considering the decline in fixed-gear catches since the early 1980s, the decrease in biomass since 1983, the recognized uncertainties in some of the input parameters to the stock

assessment process, the subcommittee concluded that quota transfer from fixed to mobile gear would result in a decline in the biomass available to the fixed gear and would consequently accentuate the decline in fixed-gear catches.

The use of commercial CPUE at age in ADAPT had been hampered by the possibility of auto-correlation when the catch at age used to calculate the CPUE represented a significant proportion of the total catch at age. Simulations showed that this was not the case and in addition, these analyses have the benefit of incorporating more information on age.

The cod/haddock/pollock regulatory system in southwestern Nova Scotia that was implemented by Fisheries and Habitat Management Branch in 1989 was reviewed. This system called for a global TAC for divisions 4X/5YZc cod and haddock and 4VW/5YZc pollock for mobile gear under 65' and was instituted in an attempt to improve statistics. While it was unclear whether this regulatory system would continue, the subcommittee expressed concern that global quotas offered no protection for the more desirable, and overexploited, cod and haddock stocks while the fishery was open. The cod-haddock-pollock quota also encouraged discarding of the relatively low priced pollock. The subcommittee suggested that the benefits of improvements to the accuracy of statistics must be weighed against the increased potential damage to cod and haddock stocks. In addition, the global quota was inconsistent with the advice that there be no directed fishery in 4X haddock.

A model for the management of transboundary stocks was reviewed and a recommendation was made that further studies be conducted along the lines of: 1) general simulations to examine the effects of various factors such as differential partial recruitment vectors between the two fleets, different distribution of recruitment between the two areas, and various possible stock recruitment relationships; and 2) focused simulations should be conducted in which the model is applied to a particular transboundary stock.

The subcommittee reviewed a proposal from industry to conduct an "experimental" fishery directed at large cod in divisions 2J3KL and 3NO in 1991-92. This proposal called for an allocation of 1.2 million fish per year from the two stock areas, with 1.0 million coming from divisions 2J3KL. It was noted that catches resulting from this experiment would be between 4,000-4,500 t in divisions 2J3KL and about 500 t in divisions 3NO. These catches would be in addition to existing allocations. A mean fish weight of about 5 kg from the two areas combined was suggested as the minimum allowable in the experimental fishery. The proposal suggested that some of the older fish taken in current longline fisheries are outside the age range included in stock assessment and that properly sampled longline catches would allow substantial improvement in the ability to measure the population size of cod at ages 10 and older in the two stock areas. From a review of the data, the subcommittee concluded that the proposal, as presented, offered little in the way of scientific value as an experiment. There was also concern that the current enterprise allocations would be allocated to other fleets and that any experimental catch would be over and above the existing quotas. There was concern about the stock in divisions 3NO and it was concluded that an additional catch of about 2,150 t could not be justified. However, the subcommittee concluded that an increased catch was possible for the longline fishery, and that harvesting strategies directed at older cod should be encouraged and, if implemented, monitored closely.

Redfish stock structure was identified by the subcommittee as a subject area that needs further research since the fish distribution does not appear to conform with currently defined stock boundaries. In addition, biochemical, morphological and meristic evidence supported the existence of two species of redfish and the subcommittee encouraged the work presently ongoing to determine the genetic identity of these species and their populations. A two-species model for redfish assessments was also reviewed. This model identified some of the information needed for a review of a mixed-stock fishery and it was suggested that the general modelling approach might be applicable to other mixed-stock fisheries.

The subcommittee reviewed a study examining cod stock structure in the 4Xs/5Yb area which was initiated in response to a request from industry for a biological interpretation of cod stock structure around

Grand Manan. The subcommittee concluded that the degree of mixing within 4X precluded definition of a separate stock in 4Xs/5Yb and hence a separate management unit for this area was inappropriate. Partitioning the total 4X cod TAC with a separate 4Xs/5Yb allocation based on average distribution patterns may be an alternative to a separate management unit. The subcommittee also noted that the past practice of including reported mobile gear catches in 5Yb with the 4X catch was consistent with the observed distribution of landings. However, it may be more appropriate to consider the entire 4X/5Yb area as a single management unit and the subcommittee recommended that inclusion of all 5Yb catches in the 4X assessment be investigated. Implications of a combined 4X/5Yb management unit for gear or geographic distribution of catches will necessitate development of appropriate allocations to ensure equitable distribution of catches.

The subcommittee reviewed the results of the deliberations of the Statistics, Sampling and Surveys Subcommittee on the morphometric and meristic characteristics of white hake in Division 4T, which suggest that there may be two distinct components composed of those from the shallow areas of the southern Gulf and those along the Laurentian Channel in depths in excess of 200 m (Res. Doc. 90/68). Current indications are there is a small directed fishery on hake with most of the landings coming from the inshore component of the southern Gulf. The subcommittee considered the data on this stock insufficient for provision of annual advice other than a TAC at the long-term average of 6,000 t, and suggested other measures be investigated as possible alternatives to manage this stock.

The steering committee had suggested a review of commercial catch rate data because it may not be considered a reliable index of stock abundance in many of the groundfish assessments. There is a general perception that changes in the efficiency of commercial fishing gear have occurred over time and, consequently the trends in catch rate do not in general appear to respond to changes in population size. The subcommittee noted that only two or three groundfish assessments use commercial catch rate data at present and that there have been few studies that have analyzed changes in catch rates in relation to changes in mobile gear efficiency. Without these analyses, it is difficult to specify what effort data should or should not be collected in logbooks and the existing logbook data were not considered sufficient to identify changes in gear efficiency. Additional factors such as vessel and gear attributes, the experience of the captain and crew, changes in distribution of the populations fished, and changes in management plans may all influence this question. The subcommittee concluded that this review was premature, and was unable to specify what needs to be collected at present to evaluate changes in the efficiency of commercial fishing gear.

The subcommittee examined a length-based sequential population analysis using the ADAPT framework on data for 4VW haddock. The technique fitted all survey and catch data simultaneously and preserved information about strong year-classes. The subcommittee recommended that the technique be applied to more stocks since it may allow sequential population analyses on stocks which are difficult to age.

A series of programs for sequential population analyses was demonstrated to both the Groundfish and Pelagic subcommittees. These programs provided enhanced graphics output to help in tuning traditional cohort analyses and to assist in choosing the best model for ADAPT. Current versions of these programs will only run on MacIntosh computers. The use of graphics in the diagnostics was seen as a significant improvement in the presentation of the output. The subcommittee suggested that a similar approach be applied in the development of future programs.

**The Invertebrates and Marine Plants Subcommittee** held three meetings and two teleconferences in 1990 and advice was provided on the snow crab and scallop stocks in Ad. Docs. 90/1, 90/3 and 90/7. Material on other invertebrate stocks can be found in the research document series in: 90/17 - Scotian Shelf scallops; 90/31 - Bay of Fundy scallops; 90/81 - Grand Manan scallops; 90/13 - Grand Bank Icelandic scallops; and 90/14 - a review of the Banquereau Bank *Mactromeris polynyma* fishery for the period 1986-1989.

The subcommittee debated the question of stocks that could be considered outside CAFSAC and Newfoundland snow crab was considered a good candidate because the current information does not allow

definition of target exploitation rates or an ability to predict the biomass of the landings. It was felt that this comment applies to many of the invertebrate stocks and it was suggested that management be asked for input on the usefulness of advice currently provided by the subcommittee.

The subcommittee reviewed its mandate in general and proposed that future meetings be structured to fulfill the three primary functions of: stock reviews, detailed peer review on specific issues, and a forum for the presentation of scientific information relevant to stock assessments. This could involve instituting a system of theme meetings with special topics to focus the discussion on a particular subject area. It was suggested that one meeting per year be scheduled for the duration of one week or more. Implementation of some of these proposals will begin in 1991.

When advice was provided on shrimp stocks in 1989, CAFSAC had advised that there was little basis for adjusting TACs yearly until significant progress had been made on a better understanding of stock structure and the impact of fishing. Management plans for the Scotian Shelf, Gulf of St. Lawrence and northern shrimp adopted in 1989 were carried over to 1990. In the case of northern shrimp, the plan is not on a calendar-year basis and the relevant period of the plan in 1989-90 carried over to 1991-92. The subcommittee however reviewed the status of the shrimp stocks to ensure that the advice given in 1989 would still be applicable for an additional year and found no biological grounds to make adjustments. The one exception to this was the Sept-Isle fishery for which in-season advice was provided in 1990 indicating that an increase in the fishery of 700 t (for a total of 5,700 t) would not be expected to have a deleterious effect on the stock.

In addition to the traditional research done on shrimp stocks, a study was completed on the geographical variation in biological characteristics of shrimp from the Scotian Shelf to the Davis Strait. This paper was presented to the ICES Shellfish Symposium in June of 1990. For the northern shrimp stocks, the traditional surveys were modified to address additional biological questions. In the Gulf of St. Lawrence, an acoustic survey was conducted at the same time as the research survey to determine the applicability of this new technique for evaluating shrimp resources.

The subcommittee was asked to review questions relating to the appropriate shrimp stock areas to be used for management purposes for the northern shrimp stock; assess the impact of current fishing activity on the northern shrimp resource taking into account stock dynamics, growth rate, water temperature, and natural mortality; and to determine if the current exploitation rate used to establish TACs is an appropriate measure. The subcommittee noted that the shrimp fishing areas defined in the 1989/90 fishery were based on the most recent information on shrimp distribution in the northwest Atlantic, although it is not known if the areas of concentration constitute separate stocks. Work on stock discrimination is ongoing. In terms of the effect of fishing, the subcommittee noted that this factor has not been obvious from a review of available data for any of the northern shrimp fishing areas. Concerning the 35% exploitation rate, the subcommittee noted that previous advice had stated that "...Recent evidence suggests that the Sept-Iles shrimp population from which the rate was determined is still maintaining its productivity despite increased exploitation rates, thus leaving little basis for the target exploitation rate of 35%". This had been addressed at the December 1989 Shrimp Workshop and it had been suggested that even if reliable biomass estimates were available, target exploitation rates still need to be established. It had been suggested that experimental fishing might be deployed in a designated area to see if a collapse, or even a significant impact on a spawning stock could be induced.

A status report on the work in progress as a result of the 1987 snow crab workshop was reviewed. It was noted that the work on stock definition has not progressed as much as some of the other recommendations relating to an examination of growth, reproductive behaviour and natural mortality. The subcommittee reviewed management measures for snow crab. There was a general feeling that effort control had not worked well in the Gulf or Newfoundland fisheries and that annual catch quotas may be acceptable to management and industry. Such a catch level requires biomass projections and target rates of removal which cannot be provided based on the information available on the fisheries. Season and area closures were also examined as management tools. In terms of season, it was suggested that this should be defined in relation to a critical level of white crab in the

catches; however, this was seen as a definition that would come from management and the industry rather than one based on biology and it may vary from area to area depending on what is acceptable to the snow crab industry in various parts of the zone. Area closure was thought to offer a valuable approach, although objective criteria for defining an area for closure were not discussed.

Material was reviewed on the catchability and size structure of snow crab in relation to rectangular, pyramidal and conical traps (Res. Doc. 90/29); on the subject of terminal molt in male snow crab (Res. Doc. 90/11); on observations of the annual spring breeding of snow crab in Bonne Bay (Res. Doc. 90/5); and the long-term observations on male snow crab movement in Bonavista Bay (Res. Doc. 90/64). The effect of shell hardness on snow crab weight-width relationships (Res. Doc. 90/10) and rate of shell hardening of crab tagged in a soft-shelled condition was also reviewed.

Material was reviewed from a sampling program, using commercial vessels, undertaken by Science Branch in the Gulf Region, after the premature closure of the southwestern Gulf snow crab fishery. From this work it was concluded that in order to maximize yield per recruit, the commercial fishery should be closed when a percentage of white crab in the catch reaches a certain level and once closed, the fishery should not be reopened.

The subcommittee responded to questions on the relationship of snow crab in areas 18 and 19 in terms of stock determination, nursery grounds, and migration patterns; their relationship to the mid-shore stock fished in Area 12; their relationship with the inshore fishing zones in P.E.I.; and the impact of a spring fishery on the stocks in Area 19. It was noted that some studies on electrophoretic characteristics for snow crab revealed that there was no difference between the western and eastern Cape Breton Island stock. If Area 18 was really composed of a high proportion of morphometrically immature crab compared to Area 19, it would suggest that the area is a nursery zone and that a proportion of crab reaching maturity move out of Area 18. Due to a lack of tag returns from past tagging experiments, it was not possible to confirm this migration. The 1989 fall fishery, with a total catch of 666 t, represented the catch level at which the catch rates seem to be fairly stable. A fishery in the spring of 1990 would therefore represent an increase in the present exploitation rate since there is no recruitment between the two periods and the subcommittee had already recommended the same catch level (674 t) for the 1990 season. Plans for transition from a fall fishery to a spring fishery would have to be developed.

The subcommittee reviewed preliminary material on stock boundaries in the southern Gulf of St. Lawrence. It was noted that most of the fishery in Area 25 is on the northeast corner of the area, and biomass maps obtained by kriging suggest that there are concentrations in the Cape Breton management zones, which spill over into Area 25. Similarly, P.E.I. Area 26 appears contiguous with the fishing effort in the southwestern Gulf. This may suggest that for assessment purposes, data from all (or some) of the areas should be combined. Further review of this subject will take place in 1991.

Material was reviewed on the application of a claw size gauge to distinguish morphometrically mature from morphometrically immature snow crab. This would have an application if a regulation were developed relating to differentially fishing morphometrically mature male snow crab. The application of a claw hardness gauge (durometer) was also examined in terms of possible application as a management tool for fisheries that catch high proportions of soft-shelled crab.

A first attempt at standardizing terminology for the life stages of snow crab took place in 1990. This will be considered further in 1991.

The subcommittee reviewed the effects of increasing the minimum legal size for snow crab and did not feel that a size increase would promote stability in the fishery. The short-term effect of increasing the minimum size would be to reduce the size of the legally catchable population, thus probably also reducing the catch per unit effort of legal crabs. Whether this resulted in a lower total catch depends on how the fishery is regulated

(e.g. by fishing season or by quota). If in future seasons, the TAC were set at a high level, the exploitation rate on the large crab would be very high and the fishery would depend very heavily on recruitment. There was thus reason to believe that increasing the minimum size would promote instability in the fishery if the quota was not reduced accordingly. Although increasing the minimum size would allow males more opportunities to mate, there was no reason to believe that reproductive success is endangered at present. It was noted that the effects of a change in size on the yield per recruit cannot be evaluated reliably at this time.

Growth rate and preliminary yield per recruit values for lobster in the offshore Gulf of Maine area and southern Scotian Shelf were reported in Res. Doc. 90/78. A paper was also presented to the subcommittee on bow-mounted pushnets for larval lobster sampling; details are contained in Res. Doc. 90/23.

The status of the rockweed stock in southwest Nova Scotia and in the Annapolis Basin was reviewed. The subcommittee noted that the estimated annual sustainable yield for Lobster Bay for 1988 and 1989 has been exceeded by 1,700 t and 5,276 t respectively. Sectors D and E were being cropped at three times the estimated sustainable level. The 1989 survey showed only 15% of the beds untouched by harvesters. The lack of a harvesting strategy would mean significantly lower landings from Lobster Bay in 1990 (< 15,000 t based on continued loss of residual biomass) although the present harvesting rate in Annapolis Basin appears to be sustainable.

Two teleconferences of the subcommittee were held in 1990. One was called to assess the potential impact of an increase of the Sept-Iles shrimp quota for 1990 and the other for a review of a proposal to harvest 3,000 t of meats of 3Ps scallops. The subcommittee recommended an increase of 700 t for the fishery in Sept-Isle for a total of 5,700 t and material relating to 3Ps scallops appeared in Ad. Doc. 91/1.

The **Marine Environment and Ecosystems Subcommittee** held one meeting and one teleconference in 1990. At the teleconference, material was reviewed on the use of the Gulf of St. Lawrence as an area of ballast exchange for foreign ships on the way to the St. Lawrence Seaway. Additional information on this subject can be found in Res. Doc. 90/34. A one-day workshop on this subject is planned for 1991 outside the aegis of CAFSAC.

Plans for a workshop on juvenile ecology for the fall of 1991 were initiated by the subcommittee in 1990 and it was suggested that the following general subject areas be covered: 1) evaluation of the relationship between juvenile abundance and recruitment indices; 2) examination of the role of juvenile ecology in relation to population dynamics; and 3) identification of the importance of juvenile habitats.

The abiotic effects on cod growth were considered by the subcommittee in terms of investigation of the degree of variability in weights at age for different cod stocks in relation to changes in the fishery and the possibility that the different growth rates might be related to differences in the temperature regime or in resource availability among the various regions. In order to provide some insight on these subjects, the subcommittee mandated a working group to review the growth rates of different cod stocks in relation to hydrographic regimes notably temperature and biological productivity levels in different ecosystems. Studies on food and feeding of cod will be specifically reviewed and trophic dynamics of specific biological systems will be addressed in this context. This working group meeting is proposed for 1991.

A project proposal on the creation of an environmental data base by the Physical and Chemical Sciences from the Scotia-Fundy Region was presented to the subcommittee. This data base, which will make use of existing hydrographic data collected by DFO fisheries surveys from the Scotian Shelf and Gulf of Maine areas, will be available to DFO scientists and fisheries managers. As similar data bases are non-existent in other regions, the subcommittee was informed that request to MEDS data base using the new program called "Access to Ocean Data" should be handled with shorter turnaround time than in the past.

The **Pelagic Subcommittee** met twice in 1990, and in addition held a teleconference to review further material on the mackerel resource in the Atlantic zone. Advice was provided on capelin, herring and mackerel stocks in Ad. Doc. 90/2, 90/4 and 90/6. At the spring meeting, the subcommittee met jointly with the Groundfish Subcommittee and reviewed the analytical assessments that were attempted for the divisions 4R and 4WX herring stocks. This joint review resulted in the use of the ADAPT formulation being ruled out for the present for these stocks because of a lack of any real convergence in the matrices over the time period of the indices. For this reason the provision of advice in 90/6 for these stocks was based on other indicators of stocks status. Advice on the Newfoundland herring stock was postponed until the February meeting of 1991 because a new estimate of target strength caused a 4.5 fold decrease in biomass from the acoustic surveys.

Revised catch-at-age matrices for 4T herring (Res. Doc. 90/15) were reviewed by the subcommittee and the new matrices were incorporated into the spring assessment. The subcommittee recommended continuation of the Gulf Region's investigation of otolith characteristics associated with this stock and the use of discriminant analysis and the gonodosomatic index as appropriate classification tools in spawning group assignment.

Catch rates for 4R herring were reviewed. Beginning in 1987, standardized annual gillnet catch rates had been estimated from purchase slips for the period since 1977 using a multiplicative model on aggregated data. The herring gillnet fishery in 4R had been in decline since 1984 and this had resulted in a small sample size since about 1985. In an attempt to increase the sample sizes and, at the same time, weight the mean number of nets used in the multiplicative model by the number of landings of each fisherman, the purchase slip and questionnaire files from 1982 to 1988 were merged. This disaggregated data base was then fitted to multiplicative and other models and resulted in an improved commercial catch rate estimates. Although the subcommittee agreed that working with the disaggregated data was a preferred approach, it showed a peak in the recent trend in catch rate in 1986 rather than 1987 which was the case with the aggregated data set. The subcommittee recommended that the reason for the discrepancy be investigated further and that the results of the decrease in sample size between the early and later periods be examined.

A cursory review of natural mortality for herring was examined by the subcommittee. It was noted that, based on life history parameters such as growth rate, age at sexual maturity, maximum age, and fecundity, it is often predicted that a lower natural mortality rate should be observed in mature fall-spawning herring than in mature spring-spawning herring. Comparisons of growth, energy investment in reproduction and somatic conditions, which are life history characteristics correlated with mortality were made for spring and fall spawning herring of the west coast of Newfoundland. Without predicting absolute values of natural mortality rate, the application of the same natural mortality rate for both spawning groups was considered reasonable.

The subcommittee reviewed the reference fishing mortality for $F=0.30$ which has been used since the early 1980s as an approximation of the average $F_{0.1}$ level for Atlantic herring stocks under a variety of partial recruitment patterns. This reference fishing mortality has been applied in a weighted fashion to mature age groups for yield projections. The subcommittee reviewed the conclusions of Doubleday (1985) and confirmed that the reference fishing mortality of $F=0.30$ refers to the average fishing mortality exerted on mature age groups weighted by abundance, that is fishing mortality may exceed $F=0.30$ on particular age groups depending on the partial recruitment pattern. The subcommittee therefore recommended that catch projections continue to be based on the combination of partial recruitment vectors and age-specific fishing mortality rates which produce a weighted fishing mortality of $F=0.30$ on the mature age groups. However the steering committee disagreed and requested that the committee's previous conclusion that F on any age-group of herring should not exceed 0.30 until biological reasons to change it are offered.

The subcommittee reviewed a paper describing the software used to process bottom-window echoes in the ECOLOG acoustics system and recommended that this and other documentation for the ECOLOG system be brought together in a systems manual that would be available to users and other interested parties. The subcommittee also noted concerns that the threshold for rejection of echoes, set by the software to be 30 cm from the bottom, was insufficient to ensure that no bottom is integrated. The subcommittee recommended that

comparisons be made using the 1990 survey data to investigate the differences resulting from 30 versus 50 cm cut-offs.

Spawning group assignment for herring using otolith characteristics and histological maturity stages was reviewed. There was disagreement among the various criteria which could have been due to variability in appearance of the otolith characters and/or variability in the readers interpretation of them. Support for the former has been documented in the literature. Support for the variability in reader interpretation concept was demonstrated during a comparative study which reported that four experienced herring otolith readers assigned the same spawning season to only 60% of the fish examined from their otolith characteristics (Savard and Simoneau 1983). Alternately, these selected characteristics may not be reflecting the same phenomena in the life history of the individual. This then underlined the need to demonstrate which feature actually identifies the season of hatching. The present approach ignores these frequent discrepancies. From both the literature and the present s udy, a significant percentage of individuals assigned to one particular seasonal spawning group, as defined eithe, by individual otolith characteristics or by multivariate analyses, actually spawn during the other season. Of the characteristics examined in the present study, none showed more than 75% agreement for the combined spawning group assignments when compared with histologically determined gonadal development. The extent of the disagreement with the assigned spawning group using gonadal development suggested that there may be mixing between spring and autumn spawning stocks. This however contravened the principal assumption that the season in which an individual is born, as inferred by otolith characteristics, is the same as the season in which it will spawn as an adult. In light of the present review and the discrepancy between the present procedure for herring spawning group assignment using otolith characteristics, compared to maturity stages, and the importance of clearly defining spawning groups, the subcommittee reiterated the importance of thoroughly evaluating the methods used for identifying individuals belonging to different spawning components.

The subcommittee reviewed the results of an exploratory survey conducted in early summer 1989 using acoustic methods for mackerel in Cabot Strait. Additional work was planned for the 1990 field season and the subcommittee noted that this research needs to be pursued as a step towards provision of biomass estimates for this stock.

The **Statistics, Sampling and Surveys Subcommittee** (SSSS) held two meetings in 1990.

A method was reviewed which would allow the estimation of discards at sea in the 4T plaice fishery. The subcommittee accepted the proposed method as a reasonable way of estimating discards but noted that the method cannot be applied with confidence to data from 1984-86 because only unsexed length frequencies were collected during those years. This species exhibits significantly different growth rates for each sex after maturity and therefore length frequencies by sex are required for accurate estimation of the discards at age and eventually the catch at age. The subcommittee recommended that the sex information collected from fish in the detailed samples from the research vessel cruises as well as ancillary information which may be available, be investigated for its usefulness in estimating length frequencies by sex from the unsexed length frequencies collected on the cruises during 1984-86.

The Zonal Interchange File Format Working Group was established in 1990 as an ad hoc working group of SSSS to examine problems with sharing inter-regional commercial landing data and propose changes to the current system of exchanging and distributing these data. This group recommended the development of a zonal data base to be located on the Bedford Institute of Oceanography Cyber in the Scotia-Fundy Region using the ORACLE system to extract data, with regional data bases as required using either ORACLE or SAS software. New equipment requirements were identified to accommodate the data base and these were noted by the regions. This group also recommended modifications to the zonal interchange file format. The next phase of this project will take place in 1991 and will involve the construction of a prototype to test the proposed system.

An update on the departmental initiative relating to the Atlantic Statistics Project was presented at the spring meeting. It was noted that resources had been requested to: l) develop and implement informatics

systems; 2) implement data reliability, verification and accuracy initiatives; and 3) implement long-term changes to the statistical systems in the Gulf and Newfoundland regions. By autumn, this had become the Atlantic Fisheries Data and Information Project, and CAFSAC had been contacted through SSSS to verify scientific user requirements previously identified. Members of the subcommittee suggested that this had been done in earlier submissions.

At the request of the Groundfish Subcommittee, the subcommittee reviewed analyses on the distribution of white hake in NAFO Div. 4T (Res. Doc. 90/68) from annual and seasonal surveys. The implication of this study was that there may be more than one component to the white hake stock currently being managed in NAFO Division 4T, and since these two components may have different exploitation rates, the subcommittee recommended that the implications of a two component 'stock' on the assessment of 4T white hake be investigated.

The subcommittee reviewed a progress report from the Ageing Methodologies Working Group. For reference purposes, a report will be made available in the CAFSAC Res. Doc. series in 1991 and will include techniques for ageing; as complete a species list as possible; a glossary to define terms; and standardized terminology.

The winter surveys in NAFO Subdivision 3Pn-divisions 4RST cod were examined by the subcommittee because of concern about the high coefficients of variation in the abundance estimates derived. This survey uses a stratified random design with the number of sets allocated to strata proportional to the strata area. Ways of improving the precision of this estimate through changes to the existing strata were examined and presented to the subcommittee. It was concluded that the restratification could provide an improvement in the precision of the estimate of cod abundance in NAFO Subdivision 3Pn-divisions 4RST but that further work was needed to find better estimation procedures. There was some concern that a non-proportional allocation could cause problems with secondary survey objectives (e.g. special samples for other studies and species) and that large areas of low cod abundance might not be sampled at all. For these reasons it was suggested that some minimal sampling be done in all strata. Two-phase set allocation schemes were suggested as ways of guaranteeing a minimal level of sampling in each stratum at the first phase while allowing the second phase allocation to be used to increase the precision. The experience from previous studies of improving stratified random designs indicated that although some gain in precision can be expected by restratification, as much or more gain can be obtained through set allocation schemes. Fewer strata which are broadly related to the spatial patterns of the target species can provide the flexibility to investigate such schemes. Further investigations into ways of improving the design of the Subdivision 3Pn-divisions 4RS cod survey were encouraged.

The subcommittee reviewed some aspects of the design and analyses of groundfish survey data; these included comparative fishing (Quebec Region); survey design tools and allocation strategies (Subdivision 3Pn-divisions 4RS); stratification strategies (Scotian Shelf), and a study to estimate the abundance of cod and haddock on Georges Bank relative to the International Boundary. In terms of the comparative fishing experiment conducted in the Quebec Region, the subcommittee could not derive a meaningful conversion factor between the groundfish research surveys conducted in the northern Gulf since 1984 and the joint shrimp-redfish survey conducted this year, primarily because of the differences in the two types of survey gear. The subcommittee recommended further analyses of the difference between the two surveys and suggested that the use of the joint survey be re-evaluated. Concerning the statistical tools for evaluating allocation strategies for research surveys, the 4RS-3Pn winter survey was used as an illustrative example and the subcommittee agreed that the approach was reasonable and flexible. Some suggestions were made for further refinement.

The results of a restratification project for research vessel surveys for cod on the Scotian Shelf showed that there was little to gain with respect to increased precision from designing strata to match the spatial distribution of the age 5-12 cod. Most of the gain in efficiency was obtained by having the strata large enough to be able to adjust the allocation scheme. This resulted in potentially more sets per strata than the old scheme which had twice as many strata as the new. The new stratification/allocation scheme resulted in gains in

precision over a simple random sample design for the two experimental years, 1986 and 1987 as well as for the surveys in 1988 and 1989 for which this experimental stratification and allocation scheme were retained. On the other hand, evaluation of the 1979-1984 results showed that, for the most part, a simple random sample design would have been more efficient than the original stratification design used. Coefficients of variation (Cvs) from the 1986-1989 series were somewhat higher than those from the 1979-84 period. This trend was not consistent with what was expected from a more efficient design. However, this comparison did not take into account that the distribution patterns of cod, as reflected in the surveys, had changed over time and these changes may interact with the survey design. Therefore, the appropriate comparison should be restricted to the Cvs obtained with the efficient design and those which would have been obtained for any other design in the same year. Further work was recommended on comparing these results with the summer survey which have always used the old design. Questions were also raised regarding the efficiency of the new design for other age groups and species. However, the subcommittee recommended that efficiency estimates should be a standard part of the analysis of trawl survey results and encouraged the inclusion of the calculation in the standard analyses programs.

The subcommittee reviewed results of a study to estimate abundance of cod and haddock in the 5Zj,m (Georges Bank) management unit relative to the International Boundary. The study was based on interpretation of survey indices from two USA research surveys (spring 1968-90 and fall 1963-90) and a Canadian spring survey (1987-90) in the 5Zj,m area. The subcommittee noted that a structured approach had not been used to provide estimates of abundance for the unsurveyed part of strata. Several techniques, including a multiplicative model for estimating abundance in unsurveyed parts of strata, have been reviewed by the subcommittee in recent years and it was recommended that one or more of these techniques be used to predict values for unsurveyed areas. Once estimates of abundance for unsurveyed parts of strata are completed using a multiplicative or some other model, attention can be directed at examining seasonal variability, age-specific variability and annual variation in the abundance of haddock and cod in 5Zc and 5Zu. Results presented for 5Zj,m cod, while subject to revision when further analyses are completed, indicated substantial seasonal trends and differences in the relative abundance in 5Zc in the pre and post 1985 time period. An understanding of these trends was considered important for evaluating the appropriate average ratio of abundance in 5Zc for cod and haddock.

At the request of the Groundfish Subcommittee, the subcommittee reviewed a paper describing a formulation of ADAPT which provided a measure of precision for the projected catch. In this formulation, the projected catch and the proportion of the catch at age were estimated as parameters of the model. An advantage of this approach was that the projected catch is an explicit parameter and its precision can be determined directly and, hence, the procedure provided a simple way to take into account the covariance structure between parameter estimates. Also, such calculations may provide a means of assessing the relative reliability of different assessments on a routine basis. A disadvantage was that the variance estimates thereby obtained were strongly conditioned by the assumptions put on future partial recruitment, future mean weight at age and, for some stocks, on future recruitment and did not include all the sources of uncertainty associated with these inputs. The implications of this were that the variance of the projected catch under a multi-year scenario was likely to get smaller as the forecast horizon expanded, a situation that was not considered realistic since the departure in the estimated input for the projections from their eventual realization was important. The subcommittee noted the concerns expressed at the last meeting of the Groundfish Subcommittee with respect to the comparison of coefficients of variation calculated from ADAPT for the survivors and for the beginning of year abundance. If the coefficients of variation at the beginning of year were smaller than those for survivor estimates, then comparing the results between stocks when different estimates are being sought could be misleading. The subcommittee recognized that a single approach is desirable to facilitate comparisons and reduce the risks of misinterpretations, but had no basis to choose an approach. Further work was suggested to address the concerns raised and to compare the results from this approach with other techniques.

During 1990, preliminary planning took place for a workshop entitled "Risk Evaluation and Biological Reference Points for Fisheries Management" which is proposed for the autumn of 1991.

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**Anadromous, Catadromous and Freshwater Fishes Subcommittee**
**Summary of Advice in 1990**

Reference Documents: CAFSAC Advisory Documents 89/14, Advisory memoranda dated 90/3/22 and 90/3/29.

| Species/stock | 1989 Catches | | 1990 Catches | | Management Advice | Management Measures in 1990 |
|---|---|---|---|---|---|---|
| | Comm. and/or Native fisheries | Rec. (no.) | Comm. and/or Native fisheries | Rec. (no.) | | |
| **Arctic Charr Stock Complexes** | | | | | Advice for 1990 season | |
| Okak Bay & Cutthroat | 16.6 t | N/A | 16.1 t | N/A | Advice not given. | Quota of 26 t for Okak Bay. |
| Voisey Bay & Antons | 11.0 t | N/A | 19.9 t | N/A | No change in current management. | TAC of 17 t for Voisey Bay. |
| Nain, Anaktalik, Webb & Tikkoatokak bays; Dog and Black Islands | 51.5 t | N/A | 45.3 t | N/A | No change in current management. | Quota of 5 t for Anaktalik Bay, 16 t to Nain and Tikkoatokak bays, and 9 t to Webb Bay. |
| **Alewife and Blueback herring (Gaspereau)** | | | | | | |
| Miramichi River (Districts 70-73) | 1,682 t | N/A | 1,789 t* | N/A | A weekend closure and fishing effort similar to that of 1989 should provide catches similar to the 1985 to 1989 average 1,800 t. | Number of licenses maintained at 1974 level. In addition, a weekly close time of 12:00 hr Sat. to 18:00 hr. Sun. was enforced. |
| Margaree River | 1,123 t | N/A | 1,016 t | N/A | Current levels of exploitation are at maximum allowable. At 1989 effort levels, the 1990 catch will probably be just under 1,000 t. | 1 day/week staggered closure as per 1984 to 1988. |
| **Atlantic Salmon** | | | | | | |
| Labrador stocks (Nfld. Region only) | 289 t | 3,919 | 181 t | 2,502 | Advice not given. | Allowance catch in SFA 1 and quota in SFAs 2-11: commercial season of June 5 to Oct. 15 and recreational fishery with bag limit of 15 fish. Mandatory tagging introduced in recreational fishery in 1988 was maintained. |
| Newfoundland stocks in general (Nfld. Region only) | 456 t | 11,525 | 319 t | 17,409 | Advice not given. | |

*Preliminary

**Anadromous, Catadromous and Freshwater Fishes Subcommittee**
**Summary of Advice in 1990**

Reference Documents: CAFSAC Advisory Documents 89/14, Advisory memoranda dated 90/3/22 and 90/3/29.

| Species/stock | 1989 Catches | | 1990 Catches | | Management Advice | Management Measures in 1990 |
|---|---|---|---|---|---|---|
| | Comm. and/or Native fisheries | Rec. (no.) | Comm. and/or Native fisheries | Rec. (no.) | | |
| Newfoundland and Labrador (Gulf Region only) | 122 t | 8,348 | 87 t | 14,256 | Advice not given. | As per 1986 except SFA 13 season June 5-July 10; SFA 14 June 5-Oct. 15. Quota for SFA 13 set at 35 t and for SFA 14 at 50 t. Season bag limit on the recreational fishery remained at 15 fish. |
| Restigouche River, N.B. and Quebec | 1,812 (no.) | 7,748 | 1,742 (no.) | 8,142 | No expected change in returns from previous 5 years. | No change from 1989: no commercial fishery in Qc. and N.B.; anglers restricted to grilse only; Qc. bag limits of 1 fish/day, 7 fish/season and food fisheries with 6,995 kg quota at Restigouche Qc. and no quota at Eel River Bar, N.B. |
| | | | | | Advice for 1991 | |
| Miramichi River, N.B. | 3,425 (no.) | 24,426 | 2,719 (no.) | 21,372 | Returns of MSW salmon in 1991 will be similar to average returns observed during recent years. | No change from 1989: no commercial fishery; anglers restricted to grilse only and no quota for food fishery. |
| Saint John River, N.B. (above Mactaquac) | 1,200 (no.) (including estimate of by-catch) | 2,304 | 902 (no.) (including estimate of by-catch) | 1,600 | Possible surplus to spawning requirements of 1SW and MSW fish above Mactaquac; no advice for below Mactaquac. | Little change from 1989: no commercial fishery or legal by-catch; allocation of 919 fish to Tobique Indian Band; and anglers restricted to grilse only. |
| Margaree River, N.S. | N/A | 208 (463 MSW released) | N/A | 252 (1,693 MSW released) | No advice given. | No change from 1988: no commercial fishery and anglers restricted to grilse only. |
| Conne River, Nfld. | 382 (no.) | 1,036 | 966 (no.) | 767 | Adult returns in 1991 are expected to be no greater than 1990 returns. | Native food fishery quota maintained at 1,200 salmon less than 63 cm in length, in-season evaluation resulted in temporary closure of recreational and food fisheries. |

**Groundfish Subcommittee**
**Summary of Advice in 1990**

Nominal catches (1984-89) and TACs (1984-91) for groundfish stocks with the scientific advice for 1991 from CAFSAC Steering Committee and NAFO Scientific Council. Reference documents: nominal catches (1984-89), TACs (1984-90) and scientific advice from CAFSAC Advisory Documents 90/5 and 90/8 and NAFO Scientific Council Reports - 1990; TACs for 1991 from DFO Atlantic Groundfish Management Plan for 1991.

| Stock | Nominal Catches ('000 t) | | | | | | TACs set ('000 t) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1987[a] | 1988[a] | 1989[a] | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | Reference Level for 1991 |
| **COD** | | | | | | | | | | | | | | | |
| 2GH | 2 | 1 | 1 | + | + | + | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | (-) |
| 2J3KL | 232 | 231 | 252 | 235 | 266 | 240 | 266 | 266 | 266 | 256 | 266 | 235 | 197 | 190 | (100-215) |
| *3M | 13 | 14 | 15 | 8 | 1 | 1 | 13 | 13 | 13 | 13 | 0 | 0 | 0 | 13 | ()[o] |
| *3NO | 27 | 37 | 51 | 42 | 43 | 33 | 28[q] | 33 | 33 | 33 | 40 | 25 | 18.6 | 13.6 | (13.6-20.8) |
| 3Ps | 37 | 51 | 57 | 57 | 43 | 38 | 33 | 41[s] | 41[s] | 41[s] | 41[s] | 35.4[s] | 35.4[s] | 35.4 | (29-44.5) |
| 4RS3Pn | 104 | 88 | 80 | 67 | 48 | 47 | 100 | 100 | 92.1 | 80.3[g] | 73.9[g] | 76.5 | 58 | 35 | ( )[c] |
| 4TVn(J-A) | 55 | 62 | 64 | 51 | 52 | 50 | 67 | 67 | 60 | 45.2[g] | 54 | 54 | 53 | 48 | (48-53) |
| 4Vn(M-D) | 10 | 13 | 12 | 10 | 9 | 8 | 14 | 12 | 12 | 9 | 7.5[g] | 7.5 | 7.5 | 10 | (7.5-10) |
| 4VsW | 53 | 57 | 52 | 46 | 38 | 37 | 55 | 55 | 46 | 44 | 38 | 35.2[g] | 35.2 | 35.2 | (21-35) |
| 4X | 25 | 21 | 20 | 19 | 19 | 20 | 30 | 30 | 20 | 17.5 | 14 | 12.5[go] | 22 | 26 | (20) |
| 5Zjm[n] | 17 | 17 | 15 | 17 | 20 | 15 | 45 | 25[l] | 11[l] | 12.5[l] | 12.5[l] | 8[l] | N.A. | N.A. | (11-22) |
| **HADDOCK** | | | | | | | | | | | | | | | |
| 3Ps | 3 | 7 | 2 | 3 | 2 | 2 | - | - | - | 0.2 | 2.2 | 3.2 | N.A. | N.A. | |
| 3LNO | 2 | 4 | 6 | 6 | 8 | 7 | - | - | - | 4.1 | 8.1 | 8.1[k] | 10 | 4.1 | |
| 4TVW | 8 | 11 | 17 | 4 | 5 | 8 | 15 | 15 | 17 | .[e] | .[e] | 6.7 | 6 | [e] | (?[e]) |
| 4X | 20 | 15 | 15 | 14 | 11 | 7 | 32 | 15 | 15 | 15 | 12.4[g] | 4.6[o] | 4.6 | [e] | (?[e]) |
| 5Zjm[n] | 7 | 5 | 6 | 6 | 6 | 4 | 20 | 5.1[l] | 5.1[l] | 8.3[l] | 8.3[l] | 8.3[l] | N.A. | N.A. | (5.4) |
| **POLLOCK** | | | | | | | | | | | | | | | |
| 4VWX+5Zc[n] | 35 | 44 | 44 | 46 | 43 | 43 | 53 | 42[m] | 40[m] | 43[m] | 43[m] | 43[mo] | 43 | N.A. | (43) |
| **REDFISH** | | | | | | | | | | | | | | | |
| 2+3K | 24 | 29 | 27 | 19 | 7 | 3 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 20 | (20) |
| *3LN | 15 | 21 | 43 | 78 | 53 | 34 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 14 | (14) |
| *3M | 20 | 20 | 29 | 44 | 23 | 58 | 20 | 20 | 20 | 20 | 20 | 20 | 50 | 50 | (43) |
| 30 | 10 | 8 | 10 | 13 | 10 | 4 | 20 | 20 | 20 | 20 | 14 | 14 | 14 | 14 | (14)[k] |
| 3P | 4 | 4 | 7 | 7 | 9 | 10 | 18 | 18 | 18 | 18 | 15 | 15 | 10 | 15 | (15) |
| 4RST | 35 | 28 | 34 | 34 | 36 | 43 | 50.6 | 50.6 | 55.6 | 50 | 56 | 57 | 57 | 57 | (57) |
| 4VWX | 10 | 14 | 13 | 24 | 18 | 17 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | (30) |
| **AMERICAN PLAICE** | | | | | | | | | | | | | | | |
| 2+3K | 1 | 1 | 3 | 1 | 1 | 4 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | (10) |
| *3M | 1 | 2 | 4 | 6 | 3 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | (2) |
| *3LNO | 39[b] | 54[b] | 65[b] | 55[b] | 41[b] | 44[b] | 55 | 49 | 55 | 48 | 40 | 30.3 | 24.9 | 25.8 | (22.9-40.1) |
| 3Ps | 3 | 4 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | (4) |
| 4T[d] | 10 | 10 | 7 | 8 | 7 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | (10) |
| **WITCH** | | | | | | | | | | | | | | | |
| 2J3KL | 5 | 3 | 4 | 4 | 4 | 5 | 8 | 8 | 8 | 8 | 5 | 5 | 4 | 4 | (4) |
| *3NO | 3 | 9 | 9 | 8 | 6 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | (5) |
| 3Ps | + | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | (1) |
| 4RS | 1 | 1 | 1 | 1 | 1 | 1 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | (3.5) |
| **ATLANTIC HALIBUT** | | | | | | | | | | | | | | | |
| 3NOPs+4VWX+5Zc | 3 | 4 | 3 | 2 | 2 | 2 | - | - | - | - | 3.2[k] | 3.2[k] | 3.2[k] | 3.2[k] | (3.2)[k] |
| 4RST | + | + | + | + | + | + | - | - | - | - | 0.3[k] | 0.3[k] | 0.3[k] | 0.3[k] | (0.3)[k] |
| **GREENLAND HALIBUT** | | | | | | | | | | | | | | | |
| *SA2+3KL | 25 | 19 | 16 | 31 | 19 | 19 | 55[f] | 75 | 100 | 100 | 100 | 100 | 50 | 50 | (50) |
| *SA0+1 | 7 | 10 | 9 | 8 | 9 | 9 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 12.5 | (25) |
| 4RST | 2 | 2 | 7 | 11 | 8 | 5 | 5 | 5 | 5 | 8.9 | 10.5 | 10.5 | 10.5 | 10.5 | (-) |
| **YELLOWTAIL** | | | | | | | | | | | | | | | |
| *3LNO | 17[b] | 29[b] | 30[b] | 16 | 16[b] | 10[b] | 17 | 15 | 15 | 15 | 15 | 5 | 5 | 7 | (7) |
| **FLATFISH** | | | | | | | | | | | | | | | |
| 4VWX | 11 | 8 | 8 | 9 | 7 | 8 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | (10) |
| **ROUNDNOSE GRENADIER** | | | | | | | | | | | | | | | |
| *SA0+1 | + | + | + | + | + | + | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | (8) |
| *SA2+3 | 4 | 5 | 7 | 8 | 6 | 5 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | (11) |
| **SILVER HAKE** | | | | | | | | | | | | | | | |
| *4VWX | 74 | 75 | 83 | 62 | 74 | 91 | 100 | 100 | 100 | 100 | 120 | 135 | 135 | 100 | (100) |
| **WHITE HAKE** | | | | | | | | | | | | | | | |
| 4T | 7 | 6 | 5 | 6 | 4 | 5 | 12 | 12 | 12 | 9.4[g] | 5.5[g] | 5.5 | 5.5 | 5.5 | (-) |
| **ARGENTINE** | | | | | | | | | | | | | | | |
| 4VWX | + | + | + | + | + | + | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | (10) |

(-) Information inadequate to provide advice.
[a] Provisional statistics.
[b] Includes non-reported catch.
[c] No increase in mobile gear catch.
[d] American plaice and 90% of those recorded as "Flatfish not specified".
[e] No TAC, by-catch only
[f] Applies to Division 2J3KL only.
[g] 50% rule applied
[l] Canadian allocations for the management unit used prior to 1990.
[j] 5,000 from Division 3K, 5,000 from SA2.
[k] Precautionary TAC.
[l] Includes US allocation.
[m] Canadian quota for divisions 4VWX+SA5 1985 to 1989.
[n] Catches and advice for the new management unit.
[o] The mobile gear fleet <65' quota was included under the cod/haddock/pollock management plan in 4X for 1989 and the first half of 1990.
[p] Cessation of fishery on the Flemish Cap to allow spawning stock to rebuild.
[q] Excludes Spain.
[s] TAC set by Canada.
* Stock assessed by the Scientific Council of NAFO

| Invertebrates and Marine Plants Subcommittee<br>Summary of Advice in 1990 | | | |
|---|---|---|---|
| Reference Documents: CAFSAC Advisory Document 90/1, 90/3 and 90/7 | | | |
| **Species/stock** | **1989 Catches (Preliminary)** | **Management Advice/Options** | **Management Measures 1990** |
| Snow Crab<br><br>In general, snow crab fisheries appear to be fully developed and there is no scope for additional effort being applied under the current target exploitation rate of 50-60% based on Leslie analyses. In addition, the catches are largely based on the yearly influx of new recruits. CAFSAC is presently unable to forecast future recruitment and hence future catches. CAFSAC is thus reluctant to advise TACs except in a few cases like the Gulf coast of Cape Breton where production appears to have been relatively constant over the years or for the southern Gulf of St. Lawrence snow crab where a trawl survey is conducted yearly to estimate the biomass and a data base has started to develop to assist in the forecasting of potential catches. In most other cases, the information available on snow crab stocks generally comes from catch and effort information from the commercial fishery and can be used for assessment as opposed to prediction. CAFSAC will therefore provide status reports for all snow crab resources listed below for this year but updated advice will be provided yearly only for the southern Gulf of St. Lawrence snow crab. For the other stocks, yearly advice from CAFSAC should not be expected until significant changes occur in the management objective, in the stock itself, in the fisheries they support, or in the methodology used to assess stock sizes.<br><br>For the Gulf of St. Lawrence and P.E.I. snow crab stocks, advice for both 1990 and 1991 are included since the scientific advice for 1991 was provided in the fall of 1990. | | | |
| Southwestern Gulf | 7,882 t | For 1990. The fishery is dependent on annual recruitment and sensitive to yearly fluctuations. A lower exploitation rate to approximate 50% would make it possible to replenish the stock of morphometrically mature males and thereby provide a buffer to minimize the effects of recruitment fluctuations. This would probably result in catches of approximately 10,000 t in 1990.<br><br>CPUE is expected to be higher in 1990 than 1989 and the proportion of white crab should also be higher than in 1989. Further management measures to protect white crab should be taken to avoid wastage of the resource and allow them to contribute to the following years spawning.<br><br>For 1991. Results from surveys and the increase in white crab biomass suggest a rebuilding of the stock. CAFSAC believes that the protection given to white crab in 1990 had a positive impact on the stock and should continue in 1991. The TAC for 1990 corresponded to an exploitation rate of approximately 32%. CAFSAC believes that continuing the exploitation rate at 32%, (a TAC of 7,500 t in 1991) would allow continuation of the rapid rebuilding of this stock. However based on an estimate of pre-recruits, CAFSAC feels an exploitation rate of around 50% (catch of 11,700 t in 1991) would not significantly slow the rebuilding of the stock since good recruitment is anticipated for 1992. | The season opened April 21st and closed on June 9th. The quota was set at 7,000 t by managers and the fishery was to be closed when the percentage of white crab reached 20%. Total landings of 6,950 t were recorded compared to 7,882 t in 1989. The CPUE increased to 27.3 kg/trap haul compared to 22.1 kg/trap haul in 1989. |

| Invertebrates and Marine Plants Subcommittee<br>Summary of Advice in 1990 | | | |
|---|---|---|---|
| Reference Documents: CAFSAC Advisory Document 90/1, 90/3 and 90/7 | | | |
| **Species/stock** | **1989 Catches (Preliminary)** | **Management Advice/Options** | **Management Measures 1990** |
| | | However there are no crab smaller than 40 mm carapace width in the 1990 survey. This observation suggests that the increase in commercial-sized crab biomass that is expected for the next few years may be short-lived. | |
| Cape Breton<br>Area 19<br>(formerly Area 1) | 1,334 t | The past history of the fishery suggests that this area may not be able to produce more than 1,200 t. At the present rate of removal, a decrease in the CPUEs was expected for 1989 as occurred between 1984 and 1987. Therefore, an overall quota of around 1,200 t may help stabilize the catch rate. | The quota (1,338 t) was the same as for 1989. The season opened July 14th and closed September 15th. Landings of 1,333 t were recorded in 1990. The CPUE increased slightly from 44.5 kg/trap haul in 1989 to 46.9 kg/trap haul in 1990. |
| Cape Breton<br>Area 18<br>(formerly Area 7) | 666 t | High catches in 1982-84 may have contributed to the decline in catch rates observed from 1982-85. Catches decreased in the following years and catch rates have been relatively stable although declining slightly to about 60 kg/trap haul since 1987. The catch in 1989 comprised a large proportion of juveniles. | In 1990, an overall quota of 674 t was set. The fishery opened in the spring (April 23-27) following an agreement with groundfish fishermen. The fishery re-opened on May 29th and closed June 13th when the percentage of soft crab went over 20%. In the fall, the season was from September 3rd to November 13th. A catch of 139 t was recorded in the spring and 523 t in the fall for a total of 662 t. The CPUE was 26.1 kg/trap haul in the spring. For the fall season, the CPUE decreased from 58.1 kg/trap haul in 1989 to 50.5 kg/trap haul in 1990. |
| Prince Edward Island<br>Areas 25 and 26 | 747 t | For 1990. CAFSAC notes that a large proportion of the 1989 catches appear to have been caught very close to or outside the boundary with the southern Gulf of St. Lawrence snow crab management unit. There appears to be no discontinuity in the distribution of catches which implies that the PEI fisheries are likely exploiting snow crab from the larger southern Gulf of St. Lawrence management unit and there are indications from the trawl survey that catches within the PEI zone cannot be maintained at their current level. | The fishery opened on April 21st with an overall quota of 500 t. No boat quota was put in place. The last landings were recorded on May 18th for a total catch of 546 t. The CPUE calculated for the season was 24.8 kg/trap haul. |

| Invertebrates and Marine Plants Subcommittee<br>Summary of Advice in 1990 | | | |
|---|---|---|---|
| Reference Documents: CAFSAC Advisory Document 90/1, 90/3 and 90/7 | | | |
| **Species/stock** | **1989 Catches (Preliminary)** | **Management Advice/Options** | **Management Measures 1990** |
| | | Similar to the southern Gulf snow crab, soft-shelled snow crab should be protected to avoid wastage and to contribute to the following year's spawning. The trawl survey, albeit imprecise for the PEI zone, suggests that the biomass of male crab is about 1,000 t compared with 20,000 t for Area 12, the current management unit for the southwest Gulf of St. Lawrence.<br><br>For 1991. As given above, the indications are that these snow crab do not constitute biological units distinct from the neighbouring units. The biomass and fishing effort distribution suggest that snow crab in Area 25 are continuous with Cape Breton snow crab while distributions in Area 26 appear continuous with Area 12. | |
| Newfoundland Region<br><br>Northern Zone<br>Southern Zone<br>Labrador<br>3Ps | <br><br>2,359 t<br>4,985 t<br>523 t<br>529 t | In the northern zone CPUE increased in 1988-89 following a reduction in catches. If further increase or stabilization of catch rates were desired, a further decrease in fishing effort and catches may help meet this objective. Exploitation is particularly high in the inshore areas and reduced catches would likely be beneficial in these areas. Recently discovered large commercial-sized crab north of the area currently exploited, suggests that the CPUE in the northern zone may increase in 1990.<br><br>In the southern zone there is good recruitment in Bonavista Bay (Area 5), Conception Bay (Area 6B), and 6C, 7B, 7C, 8 and 9. Catch rates in Placentia Bay (3Ps Area 10) are low and any increased catches, if they result in increased exploitation rates may reduce the catch rates further. | Northern Zone: Inshore quota for supplementary fleet remained at 730 t. Offshore quota remained at 1,620 t.<br>Southern Zone: Overall quota remained at 6,000 t.<br>Labrador: Quota unchanged at 920 t.<br>3Ps: Quota unchanged at 600 t. |

**Invertebrates and Marine Plants Subcommittee**
**Summary of Advice in 1990**

Reference Documents: CAFSAC Advisory Document 90/1, 90/3 and 90/7

| Species/stock | 1989 Catches (Preliminary) | Management Advice/Options | Management Measures 1990 |
|---|---|---|---|
| Atlantic coast of Cape Breton Areas 20-24 (formerly Areas 2-6) | | No need to change the current management strategy. It is not possible to forecast future catches because growth is not well understood and recruitment is unpredictable. However, exploitation rates in the inshore areas 2-6 are close to the target level and catch rates remain high relative to the low rates of the early 1980s. There is a high proportion of morphometrically immature males which suggests that the current improved trend in growth and recruitment will continue for at least a further fishing season.<br><br>For the newly discovered offshore grounds in Area 6, production, biomass and other stock parameters are unknown. It is recommended that the grounds continue to be considered as a separate exploratory area from the inshore Area 6 grounds to facilitate monitoring and management. | Regulatory measures include strict licensing controls, a 30 trap/vessel limit, a summer-fall season of 8-9 weeks, and a minimum size limit of 95 mm carapace width. The season started on July 22 (Areas 20-23) and August 1 (Area 24) and ended on September 15 and September 30. |
| Area 20 | 12 t | | |
| 21 | 147 t | | |
| 22 | 94 t | | |
| 23 | 114 t | | |
| 24 | 193 t | | |
| Estuary & North Shore | | | |
| Areas 13-14 (Lower North Shore) | 168 t | In 1989 few vessels fished for snow crab and catch rates were low in 1988-89 possibly because of low recruitment. During 1988, tagging operations, it was noted that prerecruits were more abundant than 1987 and these crab may recruit to the fishery in 1990. | In 1990, individual quotas were set at the same level as in 1989. The fishing season was to commence in May in Area 13 but was delayed until June because of ice conditions. The fishery was closed one week after it had opened in June because of the high incidence of white crab in the catches. The fishery restarted in September and closed in October after 8 weeks. The preliminary catch statistics for 1990, indicate landings of 312 t. |
| Areas 15-16 (Middle North Shore) | 1,570 t | The 1989 season in these areas was good despite some incidence of white crab. Landings remained stable compared to 1988 and CPUE increased. | There were no changes to the 1989 management regime in 1990. Duration of the fishing season was 14 weeks commencing in April until July. Preliminary landings peaked at 3,135 t, a level never reached before. |
| Area 17 (Upper North Shore) | 842 t | High incidence of white crab was partly responsible for decreased catches in 1989. Landings and CPUE were relatively stable on the South Shore while CPUE decreased by nearly one-third on the North Shore. | No change was brought to the management plan of the previous year. Fishing started at the end of March and continued for 14 weeks and ended in July. Preliminary landings were 899 t. |

**Invertebrates and Marine Plants Subcommittee**
**Summary of Advice in 1990**

Reference Documents: CAFSAC Advisory Document 90/1, 90/3 and 90/7

| Species/stock | 1989 Catches (Preliminary) | Management Advice/Options | Management Measures 1990 |
|---|---|---|---|
| North coast of Gaspé | - | For 1991. A biomass survey was conducted in 1990. Biomass of large crab (>95 mm carapace width) is about 95 t ± 92 t. Distribution is restricted and stock affinity of the crab not defined. Recapture in 1991 of the snow crab tagged in 1990 may clarify the links of these crab with neighbouring management units. | Management measures will be established after the results from the 1991 spring survey is completed and the results analysed. |
| **Scallops** | | | |
| Georges Bank | 4,676 t meat | Fishing at $F_{0.1}$ would imply catches of about 3,300 t while fishing at $F_{max}$ would imply catches of about 4,800 t. CAFSAC notes that these projections assume that the age and temporal distribution of the catch in 1990 would remain similar to the recent past. | TAC of 5,200 t. Meat count measures remain same. |

**Shrimp**

In 1989, biological advice on shrimp stocks was provided for that year and for 1990. This approach was taken because the committee was unable to detect the impact of fishing at current levels and therefore there was little biological basis for the provision of advice until significant progress has been made on better understanding shrimp biology and the impact of fishing.

The one exception to the above was the Sept-Isle shrimp fishery. At the request of management, in-season advice was provided in 1990 indicating that an increase in the fishery of 700 t (for a total 5,700 t) would not be expected to have a deleterious effect on the stock.

| Pelagic Subcommittee<br>Summary of Advice in 1990 | | | |
|---|---|---|---|
| Reference Documents: CAFSAC Advisory Documents 90/2, 90/4 and 90/6. | | | |
| **Species/stock** | **1989 Catches (t)*** | **Management Advice/Option**** | **Management Measures 1990** |
| **Capelin** (SA2+Div. 3K) | 50,000 | In 1990, the 1986 and 1987 year-classes will contribute most heavily to the inshore fishery, while the 1987 and 1988 year-classes will contribute most to the offshore fishery. The 1986 and 1987 year-classes dominated throughout the area surveyed acoustically. The total biomass estimated from the acoustic survey in 1989 was 1,744,000 t, and similar to the 1988 estimate. Over 95% of this biomass was estimated to be in Div. 2J. The area surveyed was expanded by about 50% in 1989 by adding additional strata in the southeast (Div. 3K) but less than 3% of the estimated biomass was detected in the expanded areas. Estimated biomass at January 1, 1990 was 1,670,000 t with an implied combined catch of 167,000 t for the 1990 fall offshore and 1991 spring inshore fisheries at a 10% exploitation rate. CAFSAC noted that recruitment in this fishery strongly influenced projected catches with a range of 148,000 t to 204,000 t based on half or twice the geometric mean recruitment. There was insufficient information to determine the implications of taking large catches in a limited inshore area and CAFSAC continued to suggest that fishing effort not be concentrated in any one area. | 21,000 t TAC offshore<br>29,000 t TAC inshore |
| **Capelin** (3Ps) | 3,098 t | Based on the observation that year-class strengths for this stock are similar to those for stocks further east, the total abundance available to the fishery in 1990 was expected to be similar to that in 1989. The relatively strong 1986 and 1987 year-classes will comprise the bulk of the mature spawning biomass in 1990.<br><br>CAFSAC noted that there is a possibility that heavy catches might have deleterious effects on localized capelin spawning stock and on inshore cod fisheries, but in the absence of any information on biomass levels, had no basis for advising what that level of catch might be. | 3,100 t TAC |
| **Capelin** (3LNO) | 3NO = 5,411 t | These stocks are assessed by NAFO. The major year-classes contributing to the mature population in Div. 3L will be those of 1986 and 1987. STACFIS | 86,000 t total TAC with |

*Preliminary statistics
**Except for capelin in SA2+Div. 3K, 3Ps and 4RST, this is for 1991.

**Pelagic Subcommittee**
**Summary of Advice in 1990**

Reference Documents: CAFSAC Advisory Documents 90/2, 90/4 and 90/6.

| Species/stock | 1989 Catches (t)* | Management Advice/Option** | Management Measures 1990 |
|---|---|---|---|
| | 3L = 50,702 t | advised that a catch of about 350,000 t would correspond to a 10% exploitation rate. Again in 1990, no projections could be made for 3NO because the 1987 and 1988 year-classes could not be estimated. Based on average spawning biomass, STACFIS indicated that exploitation of 10% would result in the catch of 30,000 t. | 3L= 56,000 t and 3NO = 30,000 t |
| **Capelin** (4RST) | 2,363 t | CAFSAC noted that until new data which will allow the determination of stock size have been accumulated, it will not be possible to assess the resource. Overall catches decreased in 1989. Catches in Div. 4S increased by a factor of 10 but this was offset by a decrease in Div. 4R catches. Previous concerns remained valid about the possible deleterious effects that heavy exploitation of near shore concentrations could have on local spawning success and on nearby inshore cod fisheries but these cannot be quantified. | 9,400 t TAC split as: 4R: 5,700 t 4S: 2,700 t 4T: 1,000 t |
| **Herring** East Coast of Newfoundland | 7,600 t | The 1982 year-class continued to predominate the fishery in 1989, but less than in 1988. In some areas, more recent year-classes (1985-87) were fairly well represented in the catches. The TAC was not taken in any of the stock areas due to poor market conditions. Biomass estimates were considered preliminary pending completion of acoustic target strength studies and CAFSAC was reluctant to provide catch projections based on biomass estimated from acoustic surveys. For White Bay-Notre Dame Bay and Bonavista Bay-Trinity Bay the 1990 TAC would exceed $F_{0.1}$ if the biomass estimated with the 1989 target strength is correct. CAFSAC therefore believed that catches should not exceed those of recent years - 13,500 t in White Bay-Notre Dame Bay and 10,000 t for Bonavista Bay-Trinity Bay. | 41,400 t TAC divided as: White Bay - Notre Dame Bay 16,500 t; Bonavista Bay - Trinity Bay 23,400 t; Conception Bay - South Shore 1,500 t. |
| **Herring** Southeast coast of Newfoundland | 500 t | Acoustic surveys to estimate biomass were completed but, as noted above, were considered preliminary because of changes in target strength parameters. CAFSAC advised precautionary TACs of 1,500 t for each of the southern areas and noted that these TACs are probably below $F_{0.1}$ exploitation. | 3,000 t TAC divided as: St. Mary's Bay - Placentia Bay 1,500 t; Fortune Bay 1,500 t |

*Preliminary statistics
**Except for capelin in SA2+Div. 3K, 3Ps and 4RST, this is for 1991.

**Pelagic Subcommittee**
**Summary of Advice in 1990**

Reference Documents: CAFSAC Advisory Documents 90/2, 90/4 and 90/6.

| Species/stock | 1989 Catches (t)* | Management Advice/Option** | Management Measures 1990 |
|---|---|---|---|
| **Herring** (4R) | 17,700 t | All catch rate series showed a significant increase from 1985 to 1987, decreased in 1988 and increased in 1989. Calibration of SPA was attempted utilizing the ADAPT procedure but was unsuccessful, probably because of low fishing mortalities. CAFSAC noted that catches of 14,000 to 22,000 t in recent years appear to have resulted in low fishing mortalities. With no evidence of significant recruitment since the 1982 year-class, CAFSAC suggested that catches should not exceed the recent 22,000 t maximum. | 35,000 t TAC |
| **Herring** (4S) | 538 t | There were no new data available to better evaluate the stock relationships in this area. CAFSAC reiterated its previous advice that present controls be adhered to and that the recent increase in fishing effort be accompanied by close biological monitoring. | 4,000 t TAC |
| **Herring** (4T) | 56,800 t | As in 1989, it was not possible to calibrate SPA for spring spawners. Catch rates did not appear to reflect abundance, and since much of the catch is sold locally, the catch statistics may not be accurate. CAFSAC had no additional information which would invalidate the analyses supporting the 1989 assessment (CAFSAC Adv. Doc. 89/11) which indicated fishing mortalities close to $F_{0.1}$ with the fishery exploiting several year-classes. As well, the 1987 year-class may be strong and there was, therefore, no reason to change in the current TAC.<br><br>Age specific calibration of SPA for fall spawners was done using ADAPT, similar to 1988 and 1989. This indicated a decrease in the age 5+ fishing mortality from 0.28 in 1988 to about 0.2 in 1989. Projections indicated that the expected catch of 53,700 t in 1990 would result in a fishing mortality of 0.31. CAFSAC noted that catch rates for both spring and fall spawners in the fall fishery had been increasing steadily, incoming recruitment for spring spawners was strong, and biomass of both spawning groups was high. CAFSAC did not have sufficient evidence to suggest any change in TAC for 1991. | 86,900 t TAC divided as:<br>Spring 21,500 t<br>Fall 65,400 t |

*Preliminary statistics
**Except for capelin in SA2+Div. 3K, 3Ps and 4RST, this is for 1991.

**Pelagic Subcommittee**
**Summary of Advice in 1990**

Reference Documents: CAFSAC Advisory Documents 90/2, 90/4 and 90/6.

| Species/stock | 1989 Catches (t)* | Management Advice/Option** | Management Measures 1990 |
|---|---|---|---|
| **Herring** (4Vn) | 2,700 t | There was insufficient information to attempt any analysis of the local stocks supporting the inshore fishery. Analyses of tagging data supported previous conclusions on movements of herring and confirmed that herring in Subdiv. 4Vn are a mixture of local and Div. 4WX and 4T stocks. However, it was still not possible to assign catches in the winter purse seine fishery to their proper components. CAFSAC reiterated that restriction of this fishery to north of Point Aconi restricted the amount of 4WX herring taken. CAFSAC considered that the summer fixed gear fishery exploits local stocks but fish taken in the winter purse seine fishery are from adjacent stocks. Again CAFSAC noted that until the stock affinities have been determined, it would be preferable to have no winter fishery in 4Vn. | 4,200 t TAC |
| **Herring** (4WX) | 84,500 t | CAFSAC has noted previously that fishing mortality estimates derived from SPA for this stock appear to be unrealistically low. Further detailed examination of the data did not alter these observations and CAFSAC was therefore unable to estimate stock size using SPA. The three indices (larval, acoustic and bottom trawl by-catch) available for this stock indicated a general increase during the 1980s followed by a decline in recent years. There was no evidence of strong recruitment. CAFSAC concluded that catches in 1991 should not exceed recent high values, that is no more than 125,000 t. | 151,200 t TAC |
| **Herring** (5Z) | -- | The fishery in this area yielded a total of about 2.7 million t between 1961 and 1977. After this, the stock collapsed. For many years there were no signs of either adults or larvae in the area, but since about 1984, larval and trawling surveys have indicated that recovery may be taking place. Larval abundance in 1989 was high and bottom trawl catches of adults indicated dominance of the 1986 year-class. The 1983, 1984, 1985 and 1987 year-classes were also abundant. Although there was continuing evidence for recovery, CAFSAC did not believe that it has been sufficient yet to support a fishery and therefore advised against any directed fishery in the area in 1991. | Closed |

*Preliminary statistics
**Except for capelin in SA2+Div. 3K, 3Ps and 4RST, this is for 1991.

**Pelagic Subcommittee**
**Summary of Advice in 1990**

Reference Documents: CAFSAC Advisory Documents 90/2, 90/4 and 90/6.

| Species/stock | 1989 Catches (t)* | Management Advice/Option** | Management Measures 1990 |
|---|---|---|---|
| **Mackerel** (Northwest Atlantic SA3-6) | 71,700 t | The initiation of joint winter fisheries in SA5-6 resulted in catches increasing from about 1,000 t in 1980 to 43,000 t in 1988. Canadian catches have fluctuated between about 16,000 t and 30,000 t since 1978. CAFSAC believes catch rate indices reflect availability and markets more than abundance. Abundance of eggs in the Gulf of St. Lawrence has generally increased since about 1983. It is believed that recent fishing mortalities have been low, too low to allow calibration of SPA. Calculation of spawning stock biomass from the egg survey estimates suggests a five-fold increase from 1983 to 1986, with stability since. CAFSAC concluded that catches similar to those observed since 1985 (about 80,000 t) would result in a low exploitation rate. Catches of 200,000 t, divided between Canada and the USA are unlikely to be harmful to the stock but CAFSAC cautioned that catches in excess of 200,000 t would not be appropriate until more information on stock status is available. | TAC set by Canada of 200,000 t divided as: 100,000 t Canada; 100,000 t USA |

*Preliminary statistics
**Except for capelin in SA2+Div. 3K, 3Ps and 4RST, this is for 1991.

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| Marine Environment and Ecosystems Subcommittee | Y. de Lafontaine |
| Marine Mammals Subcommittee | M. Kingsley |
| Pelagic Subcommittee | D.B. Atkinson (Until November 30, 1990)<br>J.J. Hunt (From December 3, 1990) |
| Statistics, Sampling and Surveys Subcommittee | S.J. Smith |

## CAFSAC Secretariat

D.E. Geddes, Executive Secretary
T.C. Dugas, Secretary

## List of Subcommittee Meetings - 1990

1. **Invertebrates and Marine Plants** meeting, January 15-18, 1990, St. John's, Newfoundland
2. **Groundfish** meeting, January 22-26, 1990, St. John's, Newfoundland
3. **Anadromous, Catadromous and Freshwater Fishes** meeting, February 5-9, 1990, St. John's, Newfoundland
4. **Pelagic** meeting, February 19-21, 1990, St. John's, Newfoundland
5. **Invertebrates and Marine Plants** meeting, March 13-16, 1990, Mont-Joli, Quebec
6. **Marine Environment and Ecosystems** teleconference, March 14, 1990
7. **Statistics, Sampling and Surveys** meeting, March 19-21, 1990, Moncton, New Brunswick
8. **Anadromous, Catadromous and Freshwater Fishes** meeting, April 30-May 5, 1990, St. John's, Newfoundland
9. **Groundfish** meeting, May 7-18, 1990, Moncton, New Brunswick
10. **Pelagic** meeting, May 7-16, 1990, Moncton, New Brunswick
11. **Pelagic** teleconference, August 29, 1990
12. **Invertebrates and Marine Plants** teleconference, September 10, 1990
13. **Groundfish** meeting, September 24-28, St. Andrews, New Brunswick
14. **Invertebrates and Marine Plants** teleconference, October 9, 1990
15. **Marine, Environment and Ecosystems** meeting, October 10-11, 1990, Halifax, Nova Scotia
16. **Statistics, Sampling and Surveys** meeting, October 23-25, 1990, Mont-Joli, Quebec
17. **Anadromous, Catadromous and Freshwater Fishes** meeting, November 20-23, 1990, Halifax, Nova Scotia
18. **Invertebrates and Marine Plants** meeting, November 7-8, 1990, Moncton, New Brunswick

## List of Steering Committee Meetings - 1990

1. January 31-February 1, 1990, Moncton, New Brunswick
2. February 23, 1990, Teleconference
3. March 6, 1990, Teleconference
4. March 22, 1990, Teleconference
5. April 2-3, 1990, St. John's, Newfoundland
6. May 29-31, 1990, Mont-Joli, Quebec
7. June 13, 1990, Teleconference
8. September 11, 1990, Teleconference
9. October 4-5, 1990, Halifax, Nova Scotia
10. October 10, 1990, Teleconference
11. December 5-6, 1990, Moncton, New Brunswick

## CAFSAC RESEARCH DOCUMENT INDEX - 1990

| Number | Title | Authors |
|---|---|---|
| 90/1 | Growth per molt of male snow **crab** Chionoecetes opilio, from Conception and Bonavista Bays, Newfoundland (17 p.) | D.M. Taylor<br>J.M. Hoenig |
| 90/2 | Status of Atlantic **salmon** in the Restigouche River in 1989 (37 p.) | R.G. Randall<br>G. Landry<br>A. Madden<br>R. Pickard |
| 90/3 | Status of Atlantic **salmon** of Grand River, Richmond Co., N.S., 1988 (18 p.) | P.G. Amiro<br>D.A. Longard |
| 90/4 | Status of Atlantic **salmon** in the Miramichi River during 1989 (36 p.) | R.G. Randall<br>D.M. Moore<br>P.R. Pickard |
| 90/5 | Changes in the composition of snow **crab** (Chionoecetes opilio) participating in the annual breeding migration in Bonne Bay, Newfoundland (18 p.) | G.P. Ennis<br>R.G. Hooper<br>D.M. Taylor |
| 90/6 | Status of Atlantic **salmon** of the Stewiacke River, 1989 (19 p.) | P.G. Amiro |
| 90/7 | **Capelin** in SA 2 and Div. 3K (28 p.) | J. Carscadden<br>B. Nakashima<br>R. Harnum<br>G. Lilly |
| 90/8 | An estimate of **capelin** (Mallotus villosus) biomass from an acoustic survey conducted in NAFO Divisions 2J3K in October, 1989 (18 p.) | D.S. Miller |
| 90/9 | The 1989 assessment for snow **crab** on the Atlantic coast of Cape Breton Island (44 p.) | R.W. Elner<br>R.E. Semple<br>M. Gillis |
| 90/10 | The effect of shell condition on male snow **crab**, Chionoecetes opilio, weight-width relationships (9 p.) | D.M. Taylor<br>W.G. Warren |
| 90/11 | A critical look at the idea of terminal molt in male snow **crabs** (*Chionoecetes opilio*) (36 p.) | E.G. Dawe<br>D.M. Taylor<br>J.M. Hoenig<br>W.G. Warren<br>G.P. Ennis<br>R.G. Hooper<br>W. Donaldson<br>A.J. Paul<br>J. MacDonald |

| Number | Title | Authors |
|---|---|---|
| 90/12 | Update of the Scotian Shelf **shrimp** - 1989 (14 p.) | M.A.E. Butler-Connolly<br>G. Robert |
| 90/13 | Exploratory survey for the Iceland **scallop** Chlamys islandica (O.F. Muller) on the eastern Grand Banks of Newfoundland, NAFO Div. 3N (23 p.) | K.S. Naidu<br>F.M. Cahill |
| 90/14 | A review of the Banquereau Bank fishery for *Mactromeris polynyma* for the 1986 to 1989 period (27 p.) | D.L. Roddick<br>E. Kenchington |
| 90/15 | Revisions of the 4T **herring** catch-at-age matrices (19 p.) | H.M.C. Dupuis<br>C.J. MacDougall |
| 90/16 | Status of Atlantic **salmon** stocks, Area K, Gulf Region, Newfoundland 1989 (24 p.) | R.R. Claytor<br>C.C. Mullins |
| 90/17 | **Scallop** fishing grounds on the Scotian Shelf - 1989 (34 p.) | G. Robert<br>M.J. Lundy<br>M.A.E. Butler-Connolly |
| 90/18 | The assessment of the **cod** stock in NAFO divisions 2J3KL (89 p.) | J.W. Baird<br>C.A. Bishop<br>W.B. Brodie |
| 90/19 | Georges Bank **scallop** stock assessment - 1989 (30 p.) | G. Robert<br>G.A.P. Black |
| 90/20 | Assessment of the Nain stock unit Arctic **charr** population in 1989 (29 p.) | J.B. Dempson |
| 90/21 | Summary of catch statistics by sub-area and assessment unit for the northern Labrador Arctic **charr** and Atlantic **salmon** fisheries in 1989 (30 p.) | J.B. Dempson<br>M. Shears |
| 90/22 | Status of Atlantic **salmon** stocks, Gulf Region, Newfoundland and Labrador, 1989 (49 p.) | R.R. Claytor<br>C.C. Mullins |
| 90/23 | A bow-mounted pushnet for measuring the fine scale distributions of **lobster** larvae (*Homarus americanus*) (13 p.) | S.C. Nolan<br>R.J. Miller |
| 90/24 | Interpreting Atlantic **salmon** (Salmo salar) angling statistics on the Margaree River, Nova Scotia (33 p.) | R.R. Claytor<br>S.F. O'Neil |
| 90/25 | Revised HYDAS calibration estimates for data acquired between May 1987 and February 1989 (6 p.) | C.R. Stevens<br>C.C. Lang |

| Number | Title | Authors |
|---|---|---|
| 90/26 | Prince Edward Island snow **crab**, Chionoecetes opilio fishery stock assessment - 1989 (18 p.) | P. DeGrâce<br>Y. Chiasson<br>M. Moriyasu |
| 90/27 | Assessment of Atlantic **salmon**, (Salmo salar), in the Margaree River, 1989 (22 p.) | R.R. Claytor<br>R. Jones |
| 90/28 | Review of the snow **crab** (Chionoecetes opilio) fishery in areas 18 and 19 (Western Cape Breton Island) for 1989 (29 p.) | Y. Chiasson<br>P. DeGrâce<br>M. Moriyasu |
| 90/29 | Study on catchability and size structure of snow **crab** (Chionoecetes opilio) in relation to three different trap types (16 p.) | M. Moriyasu<br>Y.J. Chiasson<br>P. DeGrâce |
| 90/30 | Prospects for distinguishing morphometrically mature and immature **crabs**: an alternate management strategy for the snow crab fishery (22 p.) | E.B. Safran<br>T.P. Foyle<br>R.W. Elner |
| 90/31 | Bay of Fundy **scallop** stock assessment - 1989 (35 p.) | G. Robert<br>M.A.E. Butler-Connolly<br>M.J. Lundy |
| 90/32 | Evaluation of the 1989 **gaspereau** fishery (Alosa aestivalis) and A. pseudoharengus) from the Miramichi River, New Brunswick (43 p.) | G.J. Chaput<br>C.H. LeBlanc |
| 90/33 | Assessment of the Margaree **gaspereau** fishery, 1989 (38 p.) | G.J. Chaput<br>C.H. LeBlanc |
| 90/34 | The risk to Atlantic Canadian waters of unwanted species introductions carried in ships' **ballast** (11 p.) | S.R. Kerr |
| 90/35 | Evaluation of the impacts of the Atlantic **Salmon** Management Plan (1984-88) in the Newfoundland Region (46 p.) | M.F. O'Connell<br>J.B. Dempson<br>D.G. Reddin |
| 90/36 | The status of striped **bass** in the Scotia-Fundy Region (22 p.) | B.M. Jessop |
| 90/37 | Etat des stocks de **crabe** des neiges de l'estuaire et du nord du golfe du Saint-Laurent. Evaluation 1989 (42 p.) | R. Dufour<br>J.M. Coutu |
| 90/38 | Etude de la discrimination des populations de **capelan** (Mallotus villosus) des divisions 4RST de l'OPANO (46 p.) | J.-D. Lambert<br>D. Roby<br>J.-M. Sévigny |

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| 90/39 | Effect of fishery competition on **management** choices (21 p.) | L. Fahrig |
| 90/40 | A 2-species **redfish** model (22 p.) | L. Fahrig<br>B. Atkinson |
| 90/41 | Recruitment variation in Atlantic **salmon** stocks of the inner Bay of Fundy (26 p.) | P.G. Amiro |
| 90/42 | Assessment of **pollock** (Pollachius virens) in Divisions 4VWX and Subdivision 5Zc for 1989 (63 p.) | C. Annand<br>D. Beanlands<br>J. McMillan |
| 90/43 | Status of Atlantic **salmon** (Salmo salar L.) stocks of the Newfoundland Region, 1989 (65 p.) | M.F. O'Connell<br>J.B. Dempson<br>E.G.M. Ash<br>N.M. Cochrane |
| 90/44 | Assessment of the 1989 4X **cod** fishery (46 p.) | S. Campana<br>J. Hamel |
| 90/45 | Effect of the 1984-1988 Management Plan on harvest and spawning levels of Atlantic **salmon** in the Restigouche and Miramichi rivers, New Brunswick (26 p.) | R.G. Randall |
| 90/46 | Stock status of the southern Gulf of St. Lawrence **cod** stock (4T and 4Vn (Jan.-Apr.)) in 1990/Etat du stock de **morue** du sud du Golfe du St. Laurent (4T et 4Vn (jan.-avr.)) en 1990 (58 p.) | G.A. Chouinard<br>G.A. Nielsen<br>L.G. Currie<br>J.P. Murphy |
| 90/47 | 4Vn **cod** (May to December): Status review for the 1989 fishery year (25 p.) | T.C. Lambert<br>S.J. Smith |
| 90/48 | Modelling environmentally induced change in size at age for Atlantic Canada **cod** stocks (14 p.) | R.B. Millar<br>R.A. Myers |
| 90/49 | Effects of revising 4T **herring** catch-at-age matrices in the 1989 assessment (39 p.) | R.R. Claytor<br>H.M.C. Dupuis |
| 90/50 | Assessment of the 1989 4WX **herring** fishery (48 p.) | R.L. Stephenson<br>M.J. Power<br>W.H. Dougherty<br>D.J. Gordon<br>J.B. Sochasky |
| 90/51 | A summary of the 1989 4Vn **herring** fishery (12 p.) | R.L. Stephenson<br>M.J. Power |

| Number | Title | Authors |
|---|---|---|
| 90/52 | Review of abundance indices for the 4WX **herring** assessment (41 p.) | R.L. Stephenson<br>M.J. Power<br>U. Buerkle<br>D.J. Gordon<br>J.B. Sochasky<br>W.H. Dougherty |
| 90/53 | Logbook analysis for the 4WX **herring** purse seine fishery, 1985-89 (34 p.) | M.J. Power<br>R.L. Stephenson |
| 90/54 | Reappearance of Georges Bank (5Z) **herring**: a biological update (38 p.) | R.L. Stephenson<br>M.J. Power<br>D.J. Gordon |
| 90/55 | Newfoundland southeast coast **herring** - 1990 acoustic survey results (50 p.) | J.P. Wheeler |
| 90/56 | Newfoundland east and southeast coast **herring** - 1989 assessment (43 p.) | J.P. Wheeler<br>G.H. Winters<br>R. Chaulk |
| 90/57 | Some analyses of data for **redfish** off the south coast of Newfoundland (NAFO Div. 3P/4V) (53 p.) | D.B. Atkinson<br>D. Power |
| 90/58 | Assessment of 4X **haddock** in 1989 (48 p.) | K.T. Frank<br>P.C.F. Hurley<br>J. Simon |
| 90/59 | **Redfish** in NAFO Subarea 2 and Division 3K (77 p.) | D. Power<br>D.B. Atkinson |
| 90/60 | La pêche de la **morue** dans le nord-ouest du Golfe du St. Laurent en 1989 (3Pn, 4RS), l'analyse des prises, de l'effort de pêche et l'estimation de la biomasse (53 p.) | A. Fréchet<br>P. Schwab |
| 90/61 | Estimations du mélange entre les stocks de **morue** du nord du Golfe du Saint Laurent (divisions 3Pn4RS) et les stocks adjacents (2J3KL, 3Ps, et 4TVn [Janvier-Avril]) à partir de résultats de marquage (25 p.) | D. Gascon<br>M. Aparicio<br>B. Mercille |
| 90/62 | A review of the **cod-haddock-pollock** combined quota system for the under 65' mobile gear sector in the western Scotia-Fundy Region (13 p.) | R. Mohn<br>R.G. Halliday<br>C. Annand |
| 90/63 | A snow **crab**, Chionoecetes opilio, fishery collapse in Newfoundland (12 p.) | D.M. Taylor<br>P.G. O'Keefe<br>C. Fitzpatrick |

| Number | Title | Authors |
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| 90/64 | Long term observations on tagged male snow **crab**, Chionoecetes opilio, movements in Bonavista Bay, Newfoundland (9 p.) | D.M. Taylor |
| 90/65 | Literature review on stock deliminations pertaining to the western Cape Breton Island snow **crab** (Chionoecetes opilio) and advice on a spring fishery in Area 18 (7 p.) | Y. Chiasson<br>M. Hébert |
| 90/66 | Assessment of American **plaice**, Hippoglossoides platessoides, in NAFO Division 4T (68 p.) | R. Tallman<br>I. Forest-Gallant |
| 90/67 | Results of the 1990 winter acoustic surveys of NAFO Div. 4WX **herring** stocks (22 p.) | U. Buerkle |
| 90/68 | An investigation of white **hake** (Urophycis tenuis) population structure in the southern Gulf of St. Lawrence NAFO Division 4T using morphometric and meristic characters (58 p.) | T. Hurlbut<br>D. Clay |
| 90/69 | Counts of 1SW and MSW **salmon** returns as an index of marine survival (10 p.) | P.A. Shelton<br>J.B. Dempson<br>E.M. Chadwick |
| 90/70 | Assessment of the Newfoundland snow **crab**, Chionoecetes opilio, fishery - 1989 (29 p.) | D.M. Taylor<br>P.G. O'Keefe |
| 90/71 | Striped **bass** (Morone saxatilis) from the Gulf of St. Lawrence (29 p.) | G.J. Chaput<br>R.G. Randall |
| 90/72 | Distribution and acoustic backscatter of **herring** in NAFO Division 4T, November 1989 (20 p.) | D.K. Cairns<br>J.A. Wright |
| 90/73 | Assessment of Atlantic **herring** in NAFO Division 4T, 1989/Évaluation du **hareng** de l'Atlantique dans la Division 4T de l'OPANO, 1989 (67 p.) | R.R. Claytor<br>E.M.P. Chadwick<br>H.M.C. Dupuis |
| 90/74 | White **hake** (Urophycis tenuis) from the southern Gulf of St. Lawrence: a review of the fishery in 1989 (42 p.) | D. Clay<br>T. Hurlbut |
| 90/75 | Describing the risk associated with a given quota when the stock assessment is based on sequential population analysis (13 p.) | J.M. Hoenig<br>J.W. Baird<br>V.R. Restrepo |
| 90/76 | A review of the west coast of Newfoundland (NAFO Division 4R) **herring** fishery and biological trends in 1989 (20 p.) | I.H. McQuinn<br>J. Lambert |
| 90/77 | Collected papers on fish habitat with emphasis on **salmonids** (423 p.) | ACFF<br>Subcommittee |

| Number | Title | Authors |
|---|---|---|
| 90/78 | Growth rate and preliminary Y/R values for **lobsters** in the offshore regions of the Gulf of Maine and Southern Scotian Shelf (13 p.) | D.S. Pezzack<br>D.R. Duggan |
| 90/79 | Assessment of Atlantic **salmon** of the Saint John River, N.B., above Mactaquac, 1989 (23 p.) | T.L. Marshall |
| 90/80 | Status of the Atlantic **cod** stock on Georges **Bank** in Unit areas 5Zj and 5Zm, 1978-89 (37 p.) | J. Hunt |
| 90/81 | The Grand Manan **scallop** stock assessment 1988-1989 (26 p.) | S.M.C. Robinson<br>R.A. Chandler |
| 90/82 | Areal patterns in the 2J3KL offshore **witch** fishery, 1979-89 (9 p.) | D.W. Kulka |
| 90/83 | Assessment of the Atlantic **salmon** population of Conne River, Newfoundland, in 1990 (33 p.) | J.B. Dempson |
| 90/84 | Model development for predicting multi-sea-winter Atlantic **salmon** (Salmo salar L.) returns to Saint John River, New Brunswick (28 p.) | J.A. Ritter<br>T.L. Marshall<br>P.R. Boudreau |
| 90/85 | Estimates of harvest and exploitation rates for Saint John River Atlantic **salmon** in homewater and distant fisheries (33 p.) | T.L. Marshall |
| 90/86 | Assessment of **haddock** on eastern Georges Bank (37 p.) | S. Gavaris<br>L. VanEeckhaute |
| 90/87 | Reconstruction of the 4VsW **cod** catch at age on a half-year basis (1971-1989) (28 p.) | W.J. MacEachern<br>L.P. Fanning |
| 90/88 | Stock status of 4VsW **cod** in 1989 using a half-year SPA formulation (52 p.) | L.P. Fanning<br>W.J. MacEachern |
| 90/89 | Bilan préliminaire de l'exploitation du saumon au Québec en 1990 (29 p.) | F. Caron<br>M. Shields |
| 90/90 | Situation du **saumon** de la rivière de la Trinité en 1990 (30 p.) | F. Caron |
| 90/91 | The 1989 4T **herring** gillnet questionnaire (30. p) | G. Nielsen |
| 90/92 | **Haddock** on the eastern Scotian Shelf 1990 (37 p.) | K. Zwanenburg |
| 90/93 | La pêche au **crabe** des neiges (Chionoecetes opilio) dans le sud-ouest du golfe du Saint-Laurent en 1989: L'état de la ressource et l'estimation de la biomasse (35 p.) | P. Mallet<br>E. Wade<br>M. Moriyasu<br>G.Y. Conan |

## Section II

## Advisory Documents

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Advisory Document 90/1

## Advice on the Management of Snow Crab

At its meeting of January 31-February 1, 1990, CAFSAC considered the status of snow crab resources in the Newfoundland Region, in the Estuary and North Shore of the Gulf of St. Lawrence, in the southern Gulf of St. Lawrence, along the Gulf coast of Cape Breton, and off the east coast of Cape Breton.

In general, snow crab fisheries appear to be fully developed and there is no scope for additional effort being applied under the current target exploitation rate of 50-60% based on Leslie analyses. In addition, the catches are largely based on the yearly influx of new recruits. CAFSAC is presently unable to forecast future recruitment and hence future catches. CAFSAC is thus reluctant to advise TACs except in a few cases like the Gulf coast of Cape Breton where production appears to have been relatively constant over the years or for the southern Gulf of St. Lawrence snow crab where a trawl survey is conducted yearly to estimate the biomass and a data base has started to develop to assist in the forecasting of potential catches. In most other cases the information available on snow crab stocks generally comes from catch and effort information from the commercial fishery and can be used for assessment as opposed to prediction. CAFSAC will therefore provide status reports for all snow crab resources listed in the first paragraph of this document but updated advice will be provided yearly only for the southern Gulf of St. Lawrence snow crab. For the other stocks, yearly advice from CAFSAC should not be expected until significant changes occur in the management objective, in the stock itself, in the fisheries they support, or in the methodology used to assess stock sizes.

### 1. Newfoundland

The Newfoundland snow crab fishery began in 1968 in the Hant's Harbour, Trinity Bay area. The fishery grew at a moderate pace until the late 1970s when increased demand caused a rapid expansion in effort and landings peaked at about 14,000 t in 1981. Overall landings declined to 6,600 t in 1987 but increased to 9,800 t in 1988. Currently, the fishery is managed using two zones subdivided into management areas (Figure 1). The northern zone comprises areas 3A-3D and 4 while the southern zone comprises areas 5-10.

In many management areas, landings and catch rates declined to very low levels in recent years suggesting that some stocks have been heavily exploited. Fishing began off Labrador (Area 2) and in Placentia Bay (3Ps - 10) in 1985 and Area 4 in 1984 and the increased landings in recent years are mostly due to these areas although a significant pulse of recruitment has been noted in the southern zone.

Resource management imposed quotas on all management zones during 1986 and generally has continued to do so since. These quotas were not based on biological advice but rather on the performance of the 1985 fishery. In zones where catch rates had declined to very low levels in 1985, 1986 quotas were set below 1985 landings in an attempt to improve catch rates. CAFSAC notes that advice of this nature will likely lag one year with respect to changes in stock status.

In addition to recently established quotas, other regulations in force in all management zones are logbooks, minimum legal size of 95 mm carapace width (CW), and a season (April 1-November 30). The regulation prohibiting the landing of recently molted soft-shelled crab was dropped in 1986. In 1985 supplementary fisheries were introduced in the northern zone and Placentia Bay. These fisheries were open to all vessels of at least 35' in length. Vessels are restricted to seasons of one month duration and permitted to fish only 150 traps as opposed to full-time licenses who are allowed to fish over a 9-month season and permitted to fish 800 traps. In 1988 a supplementary fishery, similar to that begun in the northern zone and Placentia Bay in 1985, was initiated in the southern zone. A total of 688 licensed vessels (617 supplementary, 71 full-time) were eligible to prosecute the snow crab fishery in the Newfoundland Region in 1989.

Catch and effort information from these fisheries is presented in the table below.

| | Southern Zone | | Northern Zone | | Labrador | | 3Ps | | Total Newfoundland | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Catch (t) | Effort ('000 trap hauls) | Catch (t) | Effort ('000 trap hauls) | Catch (t) | Effort ('000 trap hauls) | Catch (t) | Effort ('000 trap hauls) | Catch (t) | Effort ('000 trap hauls) |
| 1980 | 8190 | 527 | 628 | 58 | - | - | - | - | 8818 | 585 |
| 1981 | 12636 | 808 | 1202 | 94 | - | - | - | - | 13838 | 902 |
| 1982 | 10673 | 762 | 2505 | 215 | - | - | - | - | 13178 | 977 |
| 1983 | 6188 | 745 | 4868 | 520 | - | - | - | - | 11056 | 1265 |
| 1984 | 4476 | 679 | 5080 | 606 | - | - | - | - | 9556 | 1285 |
| 1985 | 2605 | 496 | 3953 | 670 | 311 | 20 | 602 | - | 7471 | 1186 |
| 1986 | 3467 | 490 | 3958 | 917 | 467 | 40 | 651 | - | 8543 | 1447 |
| 1987 | 3083 | 552 | 2656 | 730 | 256 | 20 | 596 | 199 | 6591 | 1511 |
| 1988 | 5903 | 641 | 2565 | 656 | 451 | 48 | 856 | 231 | 9775 | 1576 |
| *1989 | 4667 | 614 | 2277 | 442 | 523 | 50 | 520 | 111 | 7987 | 1217 |

*Preliminary

CAFSAC notes that the catch per unit of effort (CPUE) increased in 1988 and 1989 in the northern zone following the reduction in catches. If the objective were to increase and stabilize catch rates at a reasonable level, it is possible that a further decrease in fishing effort, and presumably catches may help increase the catch rate further. It appears that the exploitation rate is particularly high in inshore areas, and reduced catches would likely be more beneficial if applied to these areas. The recent discovery of an apparently large area of commercial sized crab in Labrador, north of the area currently under exploitation leads CAFSAC to believe that CPUE in the northern zone offshore will increase over 1989 levels in 1990.

In the southern zone, the biological information from samples collected in processing plants as well as on research cruises indicates good recruitment in Bonavista Bay (Area 5) and Conception Bay (Area 6B) as well as in the remaining areas of the southern zone (areas 6C, 7B, 7C, 8 and 9). The catch rates in Placentia Bay (3Ps Area 10) are low and increased catches, if they result in increased exploitation rates, may reduce the catch rates further.

2. Estuary and North Shore of the Gulf of St. Lawrence

The exploitation of snow crab in the Estuary and North Shore of the Gulf of St. Lawrence began in the early 1970s, when vessels from the Gaspé Peninsula and New Brunswick landed nearly 1,000 t in the Port-Cartier area (Figure 2). The fishery did not really begin to expand until the 1980s when catches increased from 645 t in 1979 to 5,800 t in 1985. Catches have since decreased to a level of approximately 2,600 t in 1989.

The length of the 1989 fishing season, which should have been fourteen weeks in areas 16 and 17, was shortened because of the very high proportion of white crab in the catches. The fishing season was only twelve weeks long in Area 17, and was eleven weeks long in Area 16 owing to a two-week extension granted in this area in the fall. The 1989 fishing season lasted only one week in Area 15. The 1989 spring and fall seasons in areas 13 and 14, which should have taken place between May 1-27 and September 4-30 respectively, were moved to July 31-August 18 and September 4-October 31, for approximately eleven weeks of activity in all. Moreover, the quota per licence in these two areas was reduced by half in 1989, from 36.3 to 18.1 t. In 1989, as in 1987 and 1988, fishermen in Area 13 had access to an exploratory area stretching beyond the Strait of Belle Isle to Labrador.

Recent statistical information for this fishery is given in the following table:

| Year | Area 17 (Upper North Shore) Catch (t) | Effort[1] | Areas 15 & 16 (Middle North Shore) Catch (t) | Effort[1] | Zone 13 & 14 (Lower North Shore) Catch (t) | Effort[1] |
|---|---|---|---|---|---|---|
| 1980 | 811 | | 767 | | | |
| 1981 | 1118 | | 622 | | 62 | |
| 1982 | 1893 | | 737 | | 410 | |
| 1983 | 933 | 77215 | 2142 | 174559 | 714 | 71870 |
| 1984 | 1391 | 104988 | 2341 | 181292 | 1347 | 113334 |
| 1985 | 969 | 79303 | 2460 | 212948 | 2389 | 156456 |
| 1986[2] | 720 | | 2379 | | 762 | |
| 1987 | 1123 | 108167 | 1968 | 256803 | 2207 | 273587 |
| 1988 | 1077 | 110730 | 1573 | 212556 | 930 | 231918 |
| 1989 | 842 | 122311 | 1570 | 172688 | 168 | 40837 |

[1]Includes a variable proportion of regular traps and Japanese traps. In recent years, Japanese traps have chiefly been used.

[2]In 1986, the number of regular traps authorized per licence increased form thirty to fifty in areas 13, 14, and 15, and from fifty to seventy-five in areas 16 and 17.

In Area 17, the early appearance of high concentrations of white crab was partly responsible for the 1989 decrease in catch. Landings and catch per unit of effort (CPUE) were relatively stable on the South Shore, while catch per unit of effort decreased by nearly a third on the North Shore.

Despite some problems with white crab, the 1989 season in areas 15 and 16 was good. Landings remained stable compared with 1988 figures, and CPUE increased.

In the past, CAFSAC noted significant differences between the biomass estimates derived from Leslie analyses and the figures obtained by tagging in areas 13 and 14. Theoretical calculations based on trap haul and the area within which traps had attracted crabs were used in an attempt to determine which of these estimates was the most reliable. The results, based on assumptions made with respect to the attraction area of a trap, overlap those obtained using the two other methods and it was therefore impossible to determine which of the estimates was most reliable.

In 1989, few vessels fished for snow crab in areas 13 and 14. The catch rate was particularly low in 1988 and 1989, possibly because of low recruitment. During 1988 tagging operations, it was noted that prerecruits were more abundant

than they had been in 1987; these crabs may recruit in 1990 and thus contribute to improving the fishery.

## 3. Southwest Gulf, PEI and Gulf Coast of Cape Breton Island

### 3.1. Southwest Gulf of St. Lawrence

The snow crab fishery in the southwest Gulf of St. Lawrence began in the mid-1960s. The history of this fishery can be divided into four distinct periods: exploration, implementation of the infrastructure, growth, and decrease in catch. During the exploratory phase, between 1966 and 1969, catches reached 7,600 t. They subsequently fluctuated between 4, 600 t and 7,600 t until 1977, when they increased to 9,500 t. After 1978, the fishery experienced a growth period and landings reached a peak of 31,500 t in 1982. Between 1982 and 1984, landings fluctuated between 22,000 t and 24,000 t. They fell to 11,800 t in 1987. The 1988 catch (12,400 t) was comparable to the 1987 level.

The 1989 fishing season began on April 16, one week earlier than the 1988 season, because the Gulf was clear of ice. The season closed six weeks later (May 29) owing to the rapid drop in the catch rate, as well as discards at sea and wastage of significant numbers of white crab and crab under the minimum legal size. By the end of the season, landings had reached 7,882 t. Recent statistical information from this fishery is given in the table below:

| Year | CPUE* (kg/trap) | | Total catch (tonnes) | No. of traps |
|---|---|---|---|---|
| 1968 | 30.32 | | 3939 | 129914 |
| 1969 | 38.28 | | 7580 | 198015 |
| 1970 | 52.22 | | 5634 | 107890 |
| 1971 | 47.51 | | 5374 | 113113 |
| 1972 | 42.18 | | 5392 | 127833 |
| 1973 | 19.74 | | 6969 | 353040 |
| 1974 | 25.80 | | 6704 | 259845 |
| 1975 | 31.88 | | 4632 | 145295 |
| 1976 | 23.01 | | 7568 | 328900 |
| 1977 | 29.38 | | 9537 | 324608 |
| | N.B. | Quebec | | |
| 1978 | 27.9 | 18.0 | 10462 | 438697 |
| 1979 | 35.7 | 23.8 | 15794 | 506853 |
| 1980 | 50.6 | 34.9 | 14854 | 328178 |
| 1981 | 61.8 | 34.7 | 21877 | 396759 |
| 1982 | 66.8 | 41.2 | 31585 | 499709 |
| 1983 | 65.5 | 42.7 | 24342 | 362772 |
| 1984 | 66.7 | 43.9 | 26062 | - |
| 1985 | 58.8 | 53.1 | 25158 | 439096 |
| 1986 | 48.2 | 65.5 | 24267 | 415670 |
| 1987 | 26.3 | 26.1 | 11782 | 396180 |
| 1988 | 25.1 | 21.0 | 12355 | 464867 |
| 1989 | 21.9 | 22.4 | 7882 | 330342 |

*CPUE = Catch per unit of effort, kilograms per trap hauled.

Between 1980 and 1982, both fleets replaced their rectangular 1.5 m x 1.5 m traps with larger 1.8 m x 1.8 m traps. In 1986, fishermen in Quebec and New Brunswick introduced conical traps (1.8 m diameter) and pyramidal traps (1.8 m at the base). Both fleets used mainly these two types of traps in 1988 and 1989.

The overall distribution of commercial fishing effort indicates that most of the area in the southwest Gulf of St. Lawrence containing snow crab stocks is being exploited.

Overall, sampling carried out onboard commercial vessels involved in the crab fishery in the southwest Gulf of St. Lawrence revealed an increase in the proportion of white crab from 8% in 1988 to 37% in 1989. The proportion of juvenile males increased from 13% in 1988 to 28% in 1989.

From August 15 to November 8, 1989, surveys using a twenty-meter Nephrops trawl were conducted throughout the southwest Gulf of St. Lawrence and Chaleur Bay area where snow crab can be found. During this period, 172 hauls were carried out and 22,018 crab (9,775 males and 12,243 females) were caught. The biomass of male crabs with carapace widths greater than 95 mm, as estimated by trawl surveys, was greater in 1989 than in 1988: approximately 20,000 t in 1989 compared with nearly 8,000 t during the previous survey.

In Advisory Document 89/2, CAFSAC pointed out the need to assess the efficiency of the Nephrops trawl before using the results as a basis for forecasting catch. CAFSAC has not yet formally assessed the efficiency of this type of trawl; however, it is unlikely that the actual crab biomass is less than that estimated by trawling. The snow crab fishery in the southwest Gulf of St. Lawrence now depends almost exclusively on annual recruitment and is therefore extremely sensitive to yearly fluctuations in the number of individuals reaching the minimum legal size. An exploitation rate lower than that of the past few years, which probably exceeded 60%, would make it possible to replenish the stock of morphometrically mature male crabs, thereby providing a buffer that would minimize the effects of fluctuations in recruitment. Reducing the exploitation rate to approximately 50% (the lower limit of the current target range) would be a step in the right direction and would probably result in catches of approximately 10,000 t in 1990.

CAFSAC expects that the CPUE will be higher in 1990 than it was in 1989. According to the results of the trawl survey, the proportion of white crab should also be higher than in 1989. CAFSAC therefore considers that further measures should be taken to protect the white crab in order to avoid wastage of this resource, and allow them to contribute to the following year's spawning and to a more rapid rebuilding of the stock.

The trawl survey made it possible to identify the geographic distribution of juvenile crab stocks (Figure 3) likely to contain a high proportion of white crab, as well as the geographic distribution of morphologically mature crab stocks likely to be hard-shelled in the following spring (Figure 4). CAFSAC noted that if white crab was as abundant as anticipated, local stocks of hard-shelled crab could undergo high exploitation levels; however, CAFSAC was unsure whether these concentrations would persist.

## 3.2. Prince Edward Island

In Advisory Document 89/2, CAFSAC stated in relation to the PEI snow crab fisheries, that it would "undertake a review of the management units in these areas and will give advice on a basis that is consistent with the biological knowledge of the snow crab in these areas". This review has not been conducted because of the exceptional situation with the southern Gulf of St. Lawrence snow crab in 1989.

An experimental fishery was initiated around Prince Edward Island in 1985 when 16 permits were issued. An additional 14 permits were issued in 1986 and the original permits were converted to licenses in 1987. The statistical information from the fishery is given in the table below:

| | 1985 | | 1986 | | 1987 | | 1988 | | 1989* |
|---|---|---|---|---|---|---|---|---|---|
| | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring |
| Catch (t) | 673 | 129 | 1007 | 231 | 288 | 169 | 437 | 239 | 747 |
| Trap hauls | 11758 | 3323 | 30827 | 7179 | 19066 | 5719 | 16478 | 4813 | 15276 |
| CPUE | 48 | 38 | 33 | 32 | 15 | 30 | 27 | 48 | 48 |

*Preliminary

CAFSAC notes that a large proportion of the 1989 catches appear to have been caught very close to or outside the boundary with the southern Gulf of St. Lawrence snow crab management unit. There appears to be no discontinuity in the distribution of catches which implies that the PEI fisheries are likely exploiting snow crab from the larger southern Gulf of St. Lawrence management unit and there are indications from the trawl survey that catches within the PEI zone cannot be maintained at their current level. Similar to the southern Gulf snow crab, soft-shelled snow crab should be protected to avoid wastage and to contribute to the following year's spawning. The trawl survey, albeit imprecise for the PEI zone, suggests that the biomass of male crab is about 1,000 t compared with 20,000 t for Area 12, the current management unit for the southwest Gulf of St. Lawrence.

## 3.3. Gulf coast of Cape Breton, Nova Scotia: Area 18

Snow crab in Area 18 were first exploited in 1979 by 14 inshore vessels which were given exploratory permits allowing them to fish a maximum of 30 traps per permit. These permits were upgraded to licenses the following year and nine additional licenses were issued to explore an area farther from shore. In 1981, all 23 entrants were issued licenses and allowed to fish anywhere in Area 18. Larger mobile vessels from New Brunswick and Quebec fished in Area 18 from 1980 to 1982. In 1983, the mobile fleet did not participate in this fishery, as their season closed before the opening date of the inshore area. In 1984, the offshore vessels were excluded from the zone and northwestern and southwestern boundaries were established (Figure 5). A boat quota of 36,288 kg (80,000 lbs) was put in place for Area 18 in 1981 and retained through 1985. The corresponding overall

quota of 835 t was a preliminary figure which was used for management purposes as biological estimates were not available because of the unknown level of participation in the area by the mobile vessels. Declining catch rates, high exploitation levels and low production estimates resulted in a decrease in the boat quotas to 27,216 kg (60,000 lbs) in 1986 implying an overall quota of 626 t. In 1988, four new licenses were issued for a total of 27 fishermen and the overall quota was set at 674 t which allowed boat quota of 24,948 kg (55,000 lbs). The same management regime remained for 1989. Since 1982, the opening of the fishing season has been coordinated with the monitoring of the incidence of newly moulted (white) crabs in order to avoid the problem of poor quality of the catch with season opening in late August.

Recent statistical information from this fishery is given below:

| Year | Quota (t) | Catch (t) | # Vessels | CPUE (kg/trap haul) | Effort (#trap hauls) |
|---|---|---|---|---|---|
| 1979 | - | 213 | 14 | 48 | 4449 |
| 1980 | - | 519 | 23 | 48 | 10745 |
| 1981 | 835 | 494 | 23 | 48 | 10207 |
| 1982 | 835 | 824 | 23 | 62 | 13290 |
| 1983 | 835 | 822 | 23 | 43 | 18940 |
| 1984 | 835 | 722 | 23 | 36 | 20168 |
| 1985 | 835 | 537 | 23 | 31 | 17102 |
| 1986 | 626 | 618 | 23 | 43 | 14372 |
| 1987 | 626 | 626 | 23 | 64 | 9766 |
| 1988 | 674 | 669 | 27 | 62 | 10790 |
| 1989* | 674 | 601 | 27 | 58 | 10344 |

*Preliminary

CAFSAC notes that high catches in 1982-84 may have contributed to the decline in catch rates observed from 1982 to 1985. Catches decreased in the following years and the catch rate has been relatively stable, although declining slightly, at about 60 kg/trap haul since 1987. The catch in 1989 comprised a large proportion of juveniles.

### 3.4. Gulf coast of Cape Breton, Nova Scotia: Area 19

The Area 19 is the oldest and most productive of the Cape Breton snow crab fisheries. In 1978, an inshore fishing area (Area 19) was established on the western coast of the island to be used exclusively by inshore vessels under 13.7 m (45 ft) in length. Since 1979, the catches in this fishery have been regulated by an overall quota derived from Leslie analyses of fisheries data and by boat quota. The number of licenses as well as the boat quotas have been adjusted to decrease fishing pressure and stabilize catch rates. In 1988, good catch rates resulted in the implementation of an increase of quota per boat back to 22,680

kg (50,000 lbs) which had been in place from 1984 to 1986 for an overall quota of 1338 t. The same management regime remained in place for 1989.

The statistical information from this fishery is given in the table below:

| Year | Quota (t) | Catch (t) | # Vessels | CPUE (kg/trap haul) | Effort (# trap hauls) |
|---|---|---|---|---|---|
| 1978 | - | 1941 | 14 | 74 | 26301 |
| 1979 | 1406 | 1390 | 27 | 68 | 20346 |
| 1980 | 1225 | 1158 | 27 | 89 | 12953 |
| 1981 | 1004 | 913 | 27 | 59 | 15396 |
| 1982 | 1004 | 953 | 27 | 96 | 9927 |
| 1983 | 1004 | 906 | 27 | 82 | 11076 |
| 1984 | 1385 | 1315 | 61 | 51 | 26040 |
| 1985 | 1385 | 1234 | 61 | 35 | 35460 |
| 1986 | 1338 | 1235 | 59 | 32 | 38594 |
| 1987 | 1150 | 1151 | 59 | 30 | 37987 |
| 1988 | 1338 | 1337 | 59 | 59 | 22794 |
| 1989* | 1338 | 1332 | 59 | 45 | 29333 |

*Preliminary

The past history of the fishery suggests that this area may not be able to produce more than around 1,200 t. At the present rate of removal, a decrease in the CPUEs was expected for 1989 as occurred between 1984 and 1987. Therefore, an overall quota of around 1,200 t level may help stabilize the catch rate.

4. Atlantic Coast of Cape Breton

A directed fishery for snow crab off the northwest coast of Cape Breton Island began in 1966. Between 1976 and 1978, seven management areas were defined around the Island (Figure 5) for exclusive exploitation by inshore vessels under 45 feet (13.7 m) in length. Between 1977 and 1979, landings rose markedly in phase with effort and the expansion of the fishery to approximately 180 vessels operating in all seven areas. However, in 1982 it was postulated that the snow crabs on the Atlantic coast of Cape Breton Island (areas 2-6) were based on a resource with low, or sporadic, production because although the virgin biomass had been rapidly removed by fishing no significant recruitment had occurred. Management discontinued catch controls for areas 2-6 in 1982 to allow the existing fishermen to take advantage of whatever productivity occurs from time to time on an opportunistic basis. The regulatory measures remaining include strict licensing controls, a 30 trap/vessel limit, and a relatively short fishing season (10 weeks, July to September). Since 1987, sustained recruitment into the commercial stocks has increased fishable biomass in all areas. A previously unexploited group of snow crab was fished for the first time in the offshore part of Area 6 in 1988; four exploratory permits were issued for these offshore grounds in 1989.

Between 8.5 to 45.5% of the landed males sampled from the inshore areas in 1989 were morphometrically immature. Although the long-term biological implications of this situation remain unclear, virtually all of the mature females sampled through the 1989 fishing season carried eggs. Analyses of morphometric data also showed that large numbers of males had attained a terminal moult below the legal minimum size.

The statistical information from these fisheries is given in the table below:

| Year | No. of possible boats | No. of active boats | Catch (t) | Estimated total effort (traps hauled) | CPUE (kg/haul) |
|---|---|---|---|---|---|
| 1978 | 89 | 42 | 646 | 26,705 | 24.2 |
| 1979 | 119 | 98 | 1,621 | 57,890 | 28.0 |
| 1980 | 123 | 99 | 822 | 41,342 | 19.9 |
| 1981 | 122 | 55 | 204 | 8,801 | 23.2 |
| 1982 | 121 | 67 | 615 | 35,781 | 17.2 |
| 1983 | 122 | 97 | 307 | 30,223 | 10.2 |
| 1984 | 117 | 51 | 141 | 16,217 | 8.7 |
| 1985 | 120 | 25 | 84 | 10,115 | 8.3 |
| 1986 | 120 | 32 | 104 | 10,501 | 9.9 |
| 1987 | 104 | 64 | 360 | 27,959 | 12.9 |
| 1988 | 106 | 89 | 557 | 39,171 | 13.8 |
| 1989 | 111 | 96 | 560 | 35,116 | 16.0 |

The overall status of stocks in areas 2-6 in 1989 appears to show a slight improvement over 1988, continuing the reversal of the collapsed state noted in previous years. A pulse of males first detected as prerecruits in 1985 continued recruiting into the commercial stocks prior to the 1989 fishing season and at least maintained fishable biomass over 1988 levels in all areas. A weaker market demand for snow crab resulted in a slight decrease in estimated total fishing effort (trap hauls) but this was offset by a higher average catch rate and total landings were marginally higher than in 1988. Although 96 of a possible 111 vessels were active, only 34 logbooks were received covering 221.6 t of the total recorded catch of 560.4 t.

On the basis of the 1989 assessment for areas 2-6, CAFSAC sees no need for changes in the current management strategy. As with other snow crab stocks, it is not possible to forecast future catches because growth is not well understood and recruitment is unpredictable. However, the exploitation rates in inshore areas 2-6 are close to the target level, catch rates remain high relative to the lows in the early 1980s, and the high proportion of morphometrically immature males in the catch suggest that the current improved trend in growth and recruitment will continue for at least a further fishing season.

CAFSAC notes that data on biomass, production and other stock parameters are unknown for the newly-discovered offshore grounds in Area 6. CAFSAC recommends that the grounds continue to be considered as a separate exploratory area, distinct from the fully exploited inshore grounds of Area 6, to facilitate monitoring and management.

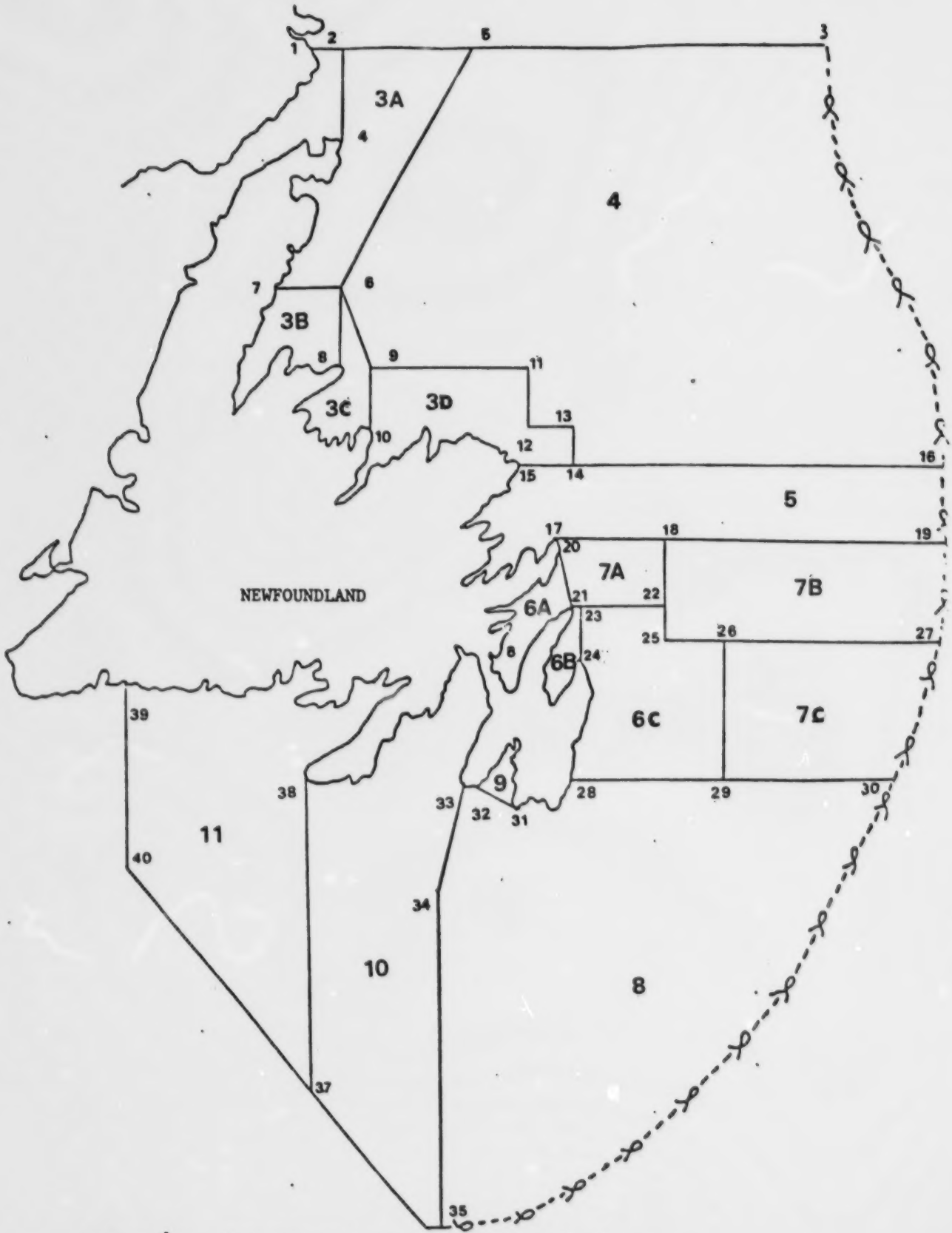


Figure 1 . New snow crab areas for Newfoundland Region.

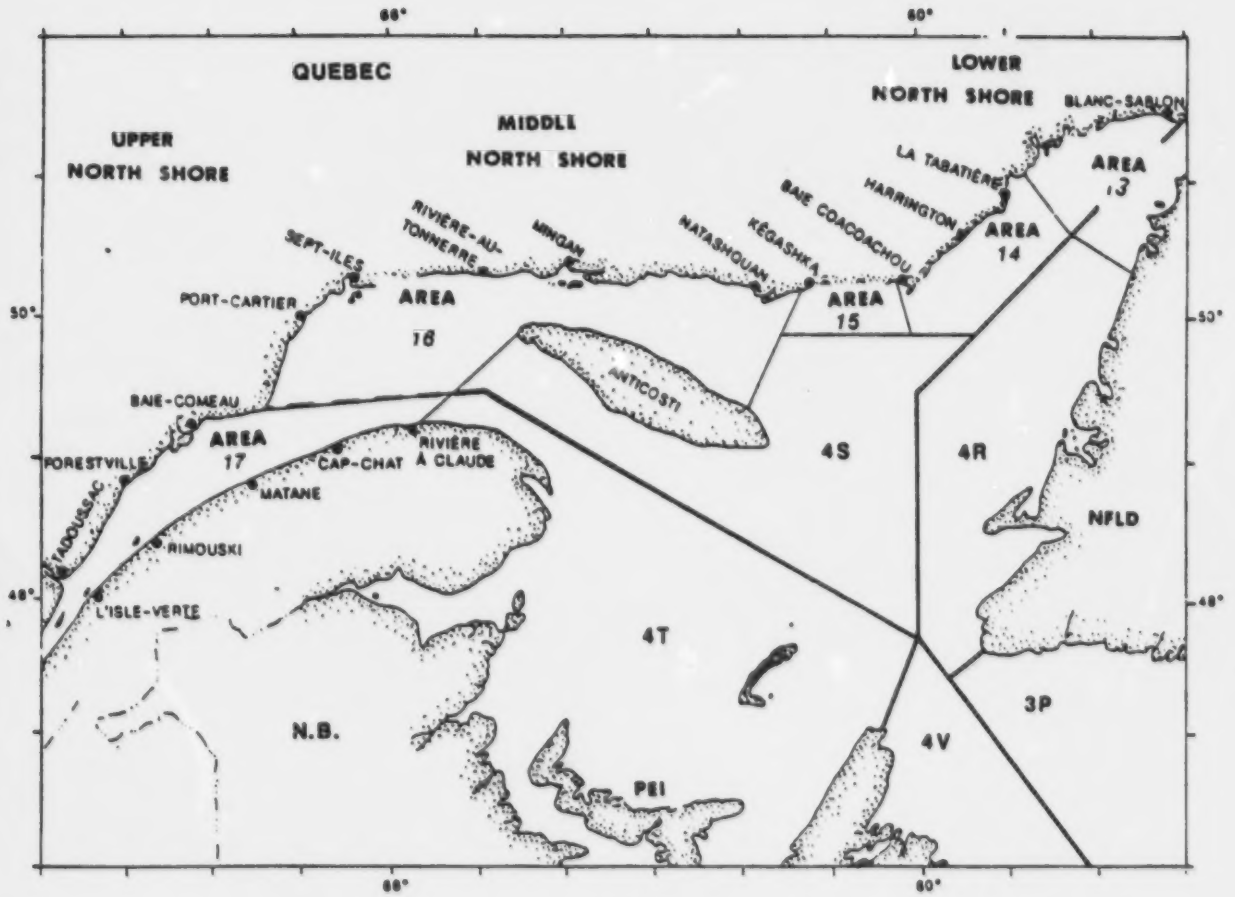


Figure 2. Gulf of St. Lawrence Estuary snow crab management areas.

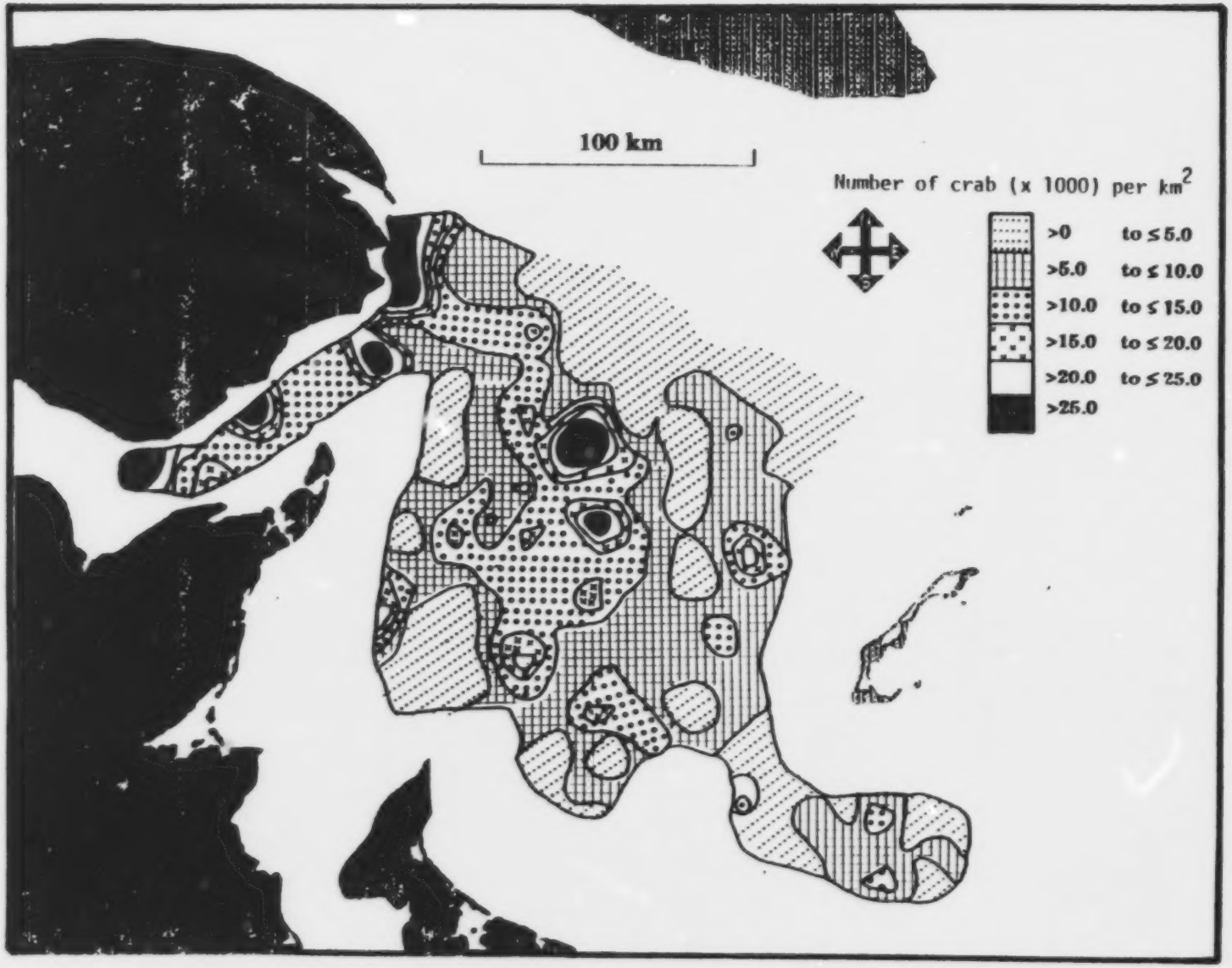


Figure 3. Density contours calculated by Kriging for immature male snow crab more than or equal to 56 mm carapace width.

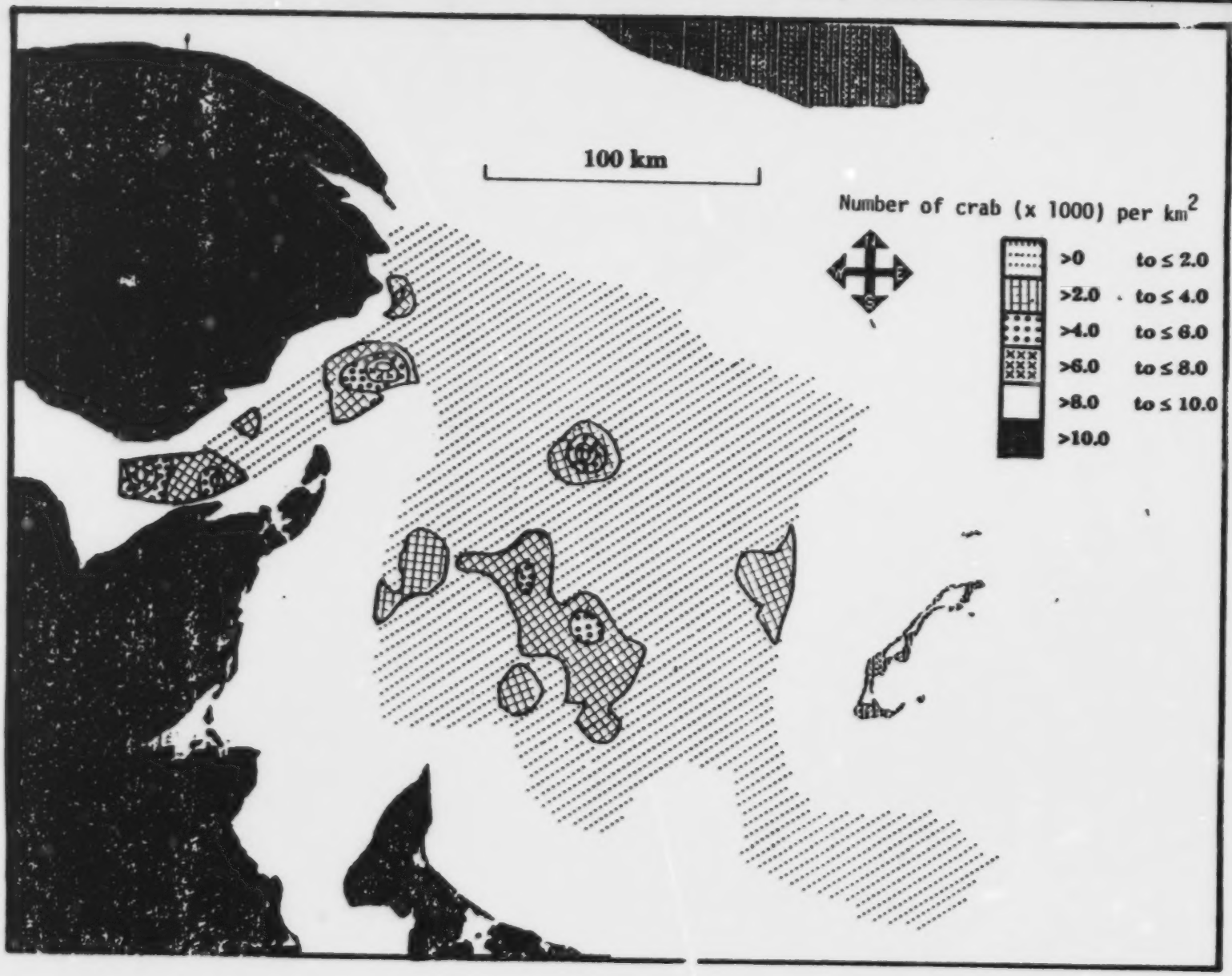


Figure 4. Density contours calculated by Kriging for mature male snow crab more than or equal to 95 mm carapace width.

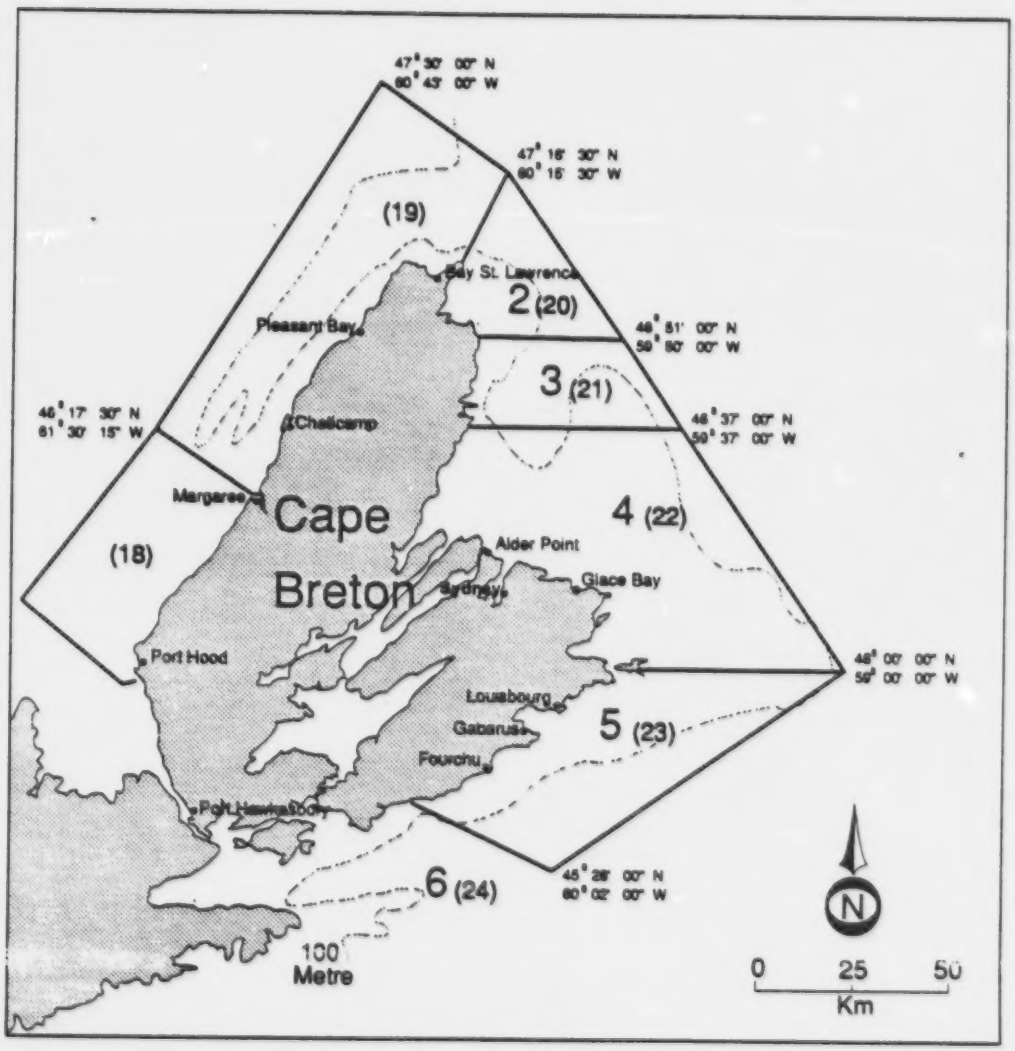


Figure 5. Snow Crab Areas around Cape Breton Island.

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Advisory Document 90/2

# Advice on the Management of Capelin Stocks in Subarea 2+3K and Updated Information on Capelin in Subdivision 3Ps and in Divisions 4RST

## 1. Capelin in Subarea 2+ Division 3K

The capelin fishery in NAFO Subarea 2 and Div. 3K was, until 1972, limited to inshore catches during the spawning season. In 1972, substantial catches were taken offshore by vessels from several countries, and these peaked at 212,000 t in 1976 before declining to 11,000 t in 1979, as a result of low capelin abundance during the late 1970s. Throughout its history, the offshore fishery has generally been conducted during the August-December period with peak catches occurring in September-November. During 1979-82 and again in 1985 and 1988, the catches were taken in Div. 2J only, but in other years catches have also been taken in Div. 3K.

During 1988 and 1989, an area was closed to the Soviet fishery in Div. 2J until October 31 because of conflicts with Canadian fixed gear fishermen. Prior to this date, in both years, the bulk of the fishery occurred north of the closed area (latitude 53° 50'N). In 1988, the fishery continued north of this area, even after the area was opened. By contrast, in 1989, the fishery moved south after October 31.

During the 1980s, an inshore directed roe fishery occurred during June and July, primarily in Div. 3K. Although the total Japanese market for capelin roe is limited, Canada has increased its share of the market in recent years following the closure of the Barents Sea fishery in 1986. This has permitted the increase in inshore effort in Div. 3K which has resulted in increased landings.

The offshore fishery first came under quota regulation in 1974 and the inshore fishery in 1982. Recent catches and TACs ('000 t) are shown below and Figure 1.

| | | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|
| Offshore | TAC | 10 | 17 | 17 | 17 | 31 | 17 | 20 |
| Nominal | catch | 10 | 17 | 17 | 17 | 30' | 17' | 23' |
| Inshore | TAC | 11 | 8 | 8 | 19 | 9 | 21.5 | 24.1 |
| Nominal | Catch | 4 | 7 | 7 | 12 | 11' | 26' | 27' |
| Total | TAC | 21 | 25 | 25 | 36 | 40 | 38.5 | 44.1 |
| | Catch | 14 | 24 | 24 | 29 | 41' | 43' | 50' |

' Preliminary statistics

Age Composition

The inshore catch during late June and early July 1989 was dominated by the 1986 year-class as 3- year-olds (69%) and the 1985 year-class as 4-year-olds (27%). The offshore catch in the fall was dominated by the 1986 year-class (54%) followed by the 1987 year-class (41%).

Abundance Indices

Abundance indices derived from the inshore and offshore components of the commercial fishery, and those from acoustic research vessel surveys are available for this stock area.

Commercial catch rates

The offshore catch per unit of effort (CPUE) calculated from data collected by Canadian observers on USSR vessels (Figure 2) suggests that abundance increased during the early to mid 1980s. The catch rates have fluctuated around a mean of about 6.5t/hr since 1985. Capelin is a schooling species and previous studies have indicated that the CPUE of the commercial fisheries exploiting such species cannot be considered precise indicators of stock trends. This conclusion was based on the observation that CPUE remained high in several fisheries despite severe declines in abundance.

Catch rate estimates for the inshore fishery were available for the purse seine fleet (1981-89) and for traps (1983-89). The purse seine index (Figure 3) showed a slight decline between 1988-89 and the trap index (Figure 4) in 1989 suggests different interpretations depending on whether catch/set or catch/day is considered. The 1987 trap catch rate is considered anomalous due to the late start of the fishery because of a labour dispute. CAFSAC considers that trap catch rates offer the best

potential as a reliable index of abundance because, as a passive gear, they should inherently exhibit the least bias.

Research vessel surveys

Acoustic surveys have been conducted by Canada for capelin in NAFO Divs. 2J3K since 1981 and the most recent survey was conducted during October 1989. The total capelin biomass estimated during each survey is given in the table below:

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|
| Acoustic estimate ('000 t) | 1494.1 | * | 94.2 | 826.4 | 1035.4 | 430.9 | 111.8 | 1803.9 | 1744.1 |
| Area surveyed ('000 km²) | 95.4 | * | 67.5 | 69.5 | 67.5 | 28.0 | 88.9 | 83.0 | 125.8 |

*Capelin detected but equipment problems precluded an estimate.

In the 1989 survey, the 1987 year-class accounted for 59% of the numbers and 49% of the biomass while the 1986 year-class accounted for 36% and 45% of the numbers and biomass respectively. The 1987 year-class was dominant throughout the survey area but percent composition of 3-year-olds decreased towards the south while that of 1-year-olds increased. Over 95% of the biomass occurred in Div. 2J.

Based on the observation from previous groundfish bottom trawl surveys that some quantities of capelin could be found outside of the area surveyed acoustically, the survey area was increased in 1989 by approximately 50%, mostly in the southeast (Div. 3K). Few capelin were detected in the expanded survey area; the two most southerly strata accounted for 56% of the total survey area but only 3% of the estimated biomass. The distribution of incidental capelin catches in groundfish surveys conducted during November and December, 1989 showed capelin to be broadly distributed. Some were caught in those areas where high density was recorded during the acoustic survey but the catches were not unusually large. Some small catches were taken outside the acoustic survey area, notably in Hawke Saddle and in the extreme northwest and southeast of the survey area. In general, capelin catches were small but were recorded from 49% of the sets, a higher proportion than in any previous year.

The USSR has conducted acoustic surveys in the area since 1974, but for most years information is not available to verify the results and therefore the estimates are not presented. The 1988 survey report was

however examined by CAFSAC and it was noted that the area of distribution of capelin agreed with the results of the Canadian acoustic and groundfish surveys.

Recruitment and Prognosis

The Canadian inshore fishery in Div. 3K exploits mature fish with ages 3 and 4 predominating. Thus, in 1990, capelin of the 1986 and 1987 year-classes will contribute most heavily to the inshore fishery. The Soviet offshore fishery in the fall exploits mainly age groups 2 and 3. Consequently, capelin of the 1987 and 1988 year-classes will contribute most heavily to this fishery in the fall of 1990. CAFSAC notes that many of the fish taken in the offshore fishery are maturing and will spawn during the next spawning season. This means that capelin of the 1987 and 1988 year-classes will contribute to the 1990 offshore fall fishery and to the 1991 inshore fishery. Accordingly, information for the management of this stock is presented on a fishery season basis, which includes the fall fishery in 1990 and the inshore fishery in 1991, rather than on a calendar year basis. Canadian acoustic surveys for both the Div. 2J3K stock and Div. 3L stock indicate that the 1986 year-class is the strongest in recent years and may therefore contribute strongly to the 1990 Canadian summer inshore fishery. The acoustic surveys indicate that the 1987 year-class is also strong. There are no estimates of the strength of the 1988 year-class available.

Based on projections of year-class strength estimates (ages 3-6) from the Canadian acoustic surveys, the biomass on July 1, 1990 would be about 1,070,000 t. This means that an inshore catch in 1990 of 107,000 t in Subarea 2+Div. 3K could be taken without exceeding 10% of the spawning biomass.

The catch in the fall fishery usually contains a high proportion of 2-year-olds. Because there are no estimates of the size of the 1988 year-class available from the acoustic survey, the geometric mean of age 2 estimates from the annual Canadian acoustic surveys, 22 billion fish, was used for age 2 in September 1990. The total biomass on September 1, 1990 would thus be about 1,670,000 t, implying a catch of 167,000 t at an exploitation rate of 10% for the fall offshore fishery in 1990 plus the inshore fishery in 1991. The values for some of the parameters used in the projections, such as proportions mature, spawning mortality, and weights are long-term means which probably fluctuate annually. Therefore, a catch of 167,000 t based on the 10% exploitation rate should be considered preliminary and used as a guide for the combined offshore fall 1990 and inshore summer 1991 fisheries. A fall acoustic survey is planned for 1990 which will give insights into incoming recruitment and a revised reference level for the summer 1991 fishery will be provided early in 1991.

To assess the influence of the assumed recruitment on projected catches, CAFSAC made projections assuming that the recruitment was either half or twice as large as the geometric mean. Assuming a 10% exploitation rate, the half geometric mean recruitment hypothesis would imply a catch of about 148,000 t

while twice the geometric mean recruitment hypothesis would imply catches of 204,000 t.

There is still not sufficient information to determine the implications of taking large catches from a limited inshore area. It is possible that doing so would have an effect on reproductive potential of the capelin that would spawn in the vicinity and also might impact the local migration of cod inshore. CAFSAC continues to suggest that fishing effort not be concentrated in any one area.

2. Capelin in Subdivision 3Ps

This stock historically produced small inshore catches, except in 1974 when the catch was 2,249 t. Since 1986 however, catches have been over 2,000 t, except in 1987 when fishing began late, resulting in a catch of only 392 t.

Recent catches and TACs (Figure 5) have been as follows (t):

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|
| TAC | - | 1,000 | 1,000 | 2,000 | 1,300 | 3,400 | 3,100 |
| Catch | 146 | 1,141 | 98 | 2,395 | 392' | 3,183' | 3,098' |

'Preliminary statistics

During the 1970s, capelin in NAFO Subdiv. 3Ps were considered to be part of a complex of stocks occurring in Div. 3LNOPs and were managed as part of this complex with a maximum of 10,000 t to be taken from the subdivision. It is now considered that capelin in Subdiv. 3Ps form a discrete stock, as shown from morphometric and meristic studies as well as the distribution of fishing activity, but there are still insufficient data on which to base an assessment.

The inshore catch in 1989 was dominated by the 1986 year-class as 3-year-olds (79.1%) followed by the 1985 year-class as 4-year-olds (17%) and the 1984 year-class 5-year-olds (1.8%). This age composition was similar to that of the inshore catch in Div. 3K.

CAFSAC notes that there is a possibility that heavy catches might have deleterious effects on localized capelin spawning stocks and on inshore cod fisheries, but in the absence of any information on biomass levels, has no basis for advising what a maximum catch might be.

3. Capelin in Divisions 4RST

As in the previous two advisory documents, CAFSAC advises that it will not be possible to provide an assessment of the capelin resource in the Gulf of St. Lawrence until there has been a substantial accumulation of new data to allow an estimation of stock size. Recent TACs and nominal catch statistics (Figure 6) are as follows (t):

| Div. | | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|
| 4R | Catch | 920 | 1,725 | 2,543 | 3,674 | 906' | 4,880' | 1,076' |
| | TAC | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 5,700 |
| 4S | Catch | - | - | 7 | - | -' | 129' | 1,090' |
| | TAC | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 2,700 |
| 4T | Catch | 103 | 180 | 545 | 227 | 67' | 59' | 197' |
| | TAC | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 1,000 |

'Preliminary statistics

Increased catches in Div. 4S are the result of new fishing permits being issued. These fisheries are market driven and rely mainly on the Japanese roe market as well as frozen product for animal consumption. Biological information including age/size structure of the commercial landings for 1989 showed that the 1986 year-class dominated in all divisions. The results of a stock discrimination study using morphometric and biochemical character sets were examined. Traditional morphometric characteristics did not indicate any stock separation while, generally, analysis of fish shape and biochemical analysis both indicate separation between western and eastern stocks in the Gulf. The analyses did not support the current separation between Div. 4T and western 4S. Sampling was insufficient to assess the biological appropriateness of the current latitude 62° 55'N boundary.

Previous concerns remain about the possible negative impact of large catches from localized concentrations on local spawning success and on nearby inshore cod fisheries. However, there is no basis to assess the level of catches that might generate these negative impacts.

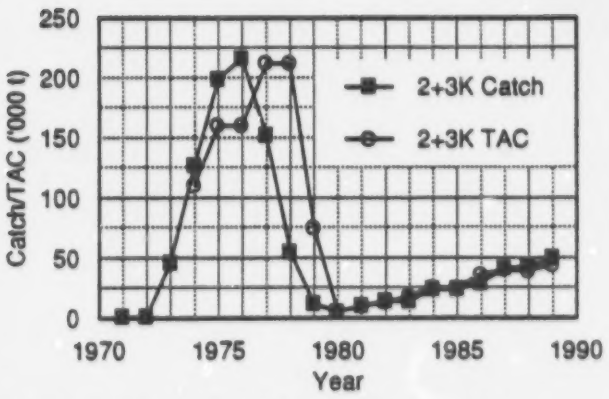


Fig. 1: Catches and TAC's for capelin in NAFO SA2 + Div. 3K.

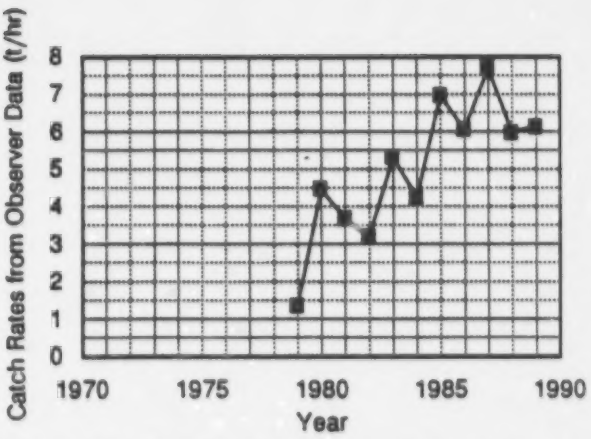


Fig. 2: Offshore catch rates for capelin in NAFO SA2 + Div. 3K from observer data.

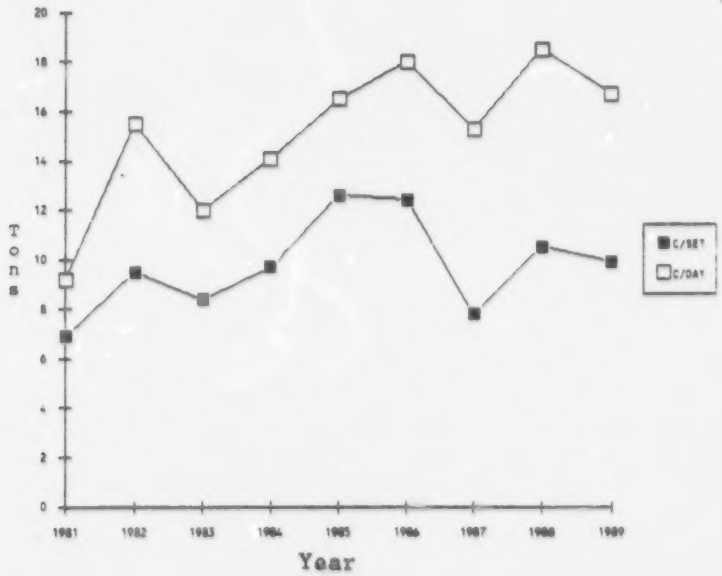


Fig. 3: Subarea 2 + Division 3K purse seine catch rates.

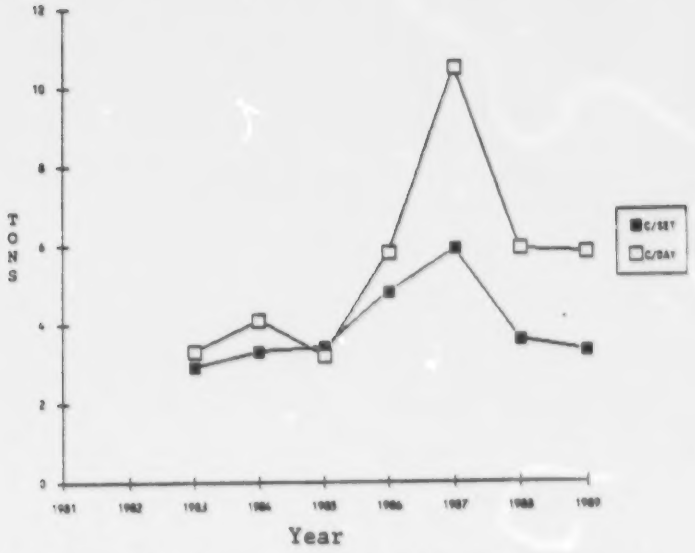


Fig. 4: Subarea 2 + Division 3K capelin trap catch per unit of effort.

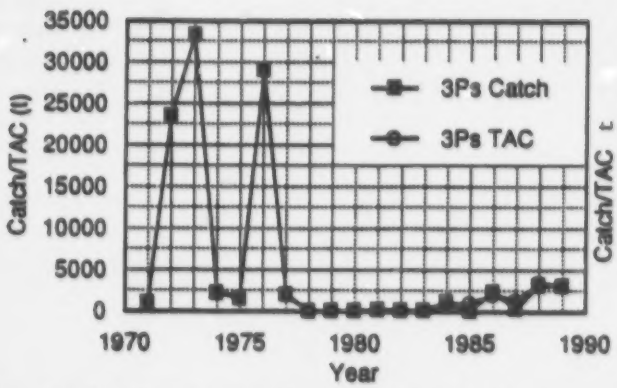


Fig. 5 : Catches and TAC's for capelin in NAFO Subdiv. 3Ps.

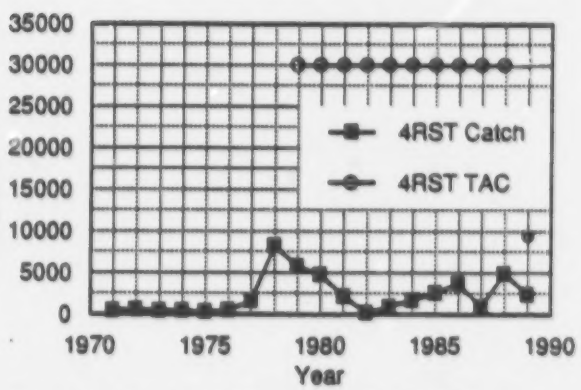


Fig. 6 : Catches and TAC's for capelin in NAFO Div. 4RST.

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Advisory Document 90/3

# Georges Bank Scallops

## 1. Introduction

The analysis of the Georges Bank scallop fishery is based on Canadian catch and fishing effort information for NAFO Subdivision 5Zc, that is for the portion of Georges Bank east of the International Court of Justice (ICJ) line established in 1984. Catches (meat weight) for Canada and the USA for 1972 to 1984 and for Canada only since 1985 are shown in Figure 1 with Canadian TACs since 1986. Since 1972, catches have averaged about 5,500 t, with maximum catches of about 11,000 t in 1977-78. Catches generally declined afterwards to about 3,000 t in 1984 and increased over the next three years. The 1989 catch was very close to the 4,700 t TAC.

The Georges Bank scallop fishery is managed under an Enterprise Allocation Plan and by an average meat count regulation as a means of controlling the size of scallops that are exploited. A relaxation of the enforcement of the meat count regulation on the Canadian fleet in 1981 led to total catches close to 10,000 t in that year. A meat count of 39 meats/500 g was imposed in 1983 and was subsequently reduced to 33 meats/500 g in 1986 to increase the yield that could be achieved from the recruiting scallops by catching older, larger animals.

## 2. Age Composition

Age composition of the Canadian catch is available since 1972. The average meat weight (and hence average age) of the catch was the lowest observed in 1981 as a result of the relaxation of the enforcement of the meat count regulation and the recruitment of a strong year-class. Scallops younger than age 5 were predominant in the catch for the following four years largely because of the low abundance of older animals but the decrease in meat count to 33 meats/500 g in 1986 forced the exploitation of older, bigger scallops. As a result, the catch has been dominated by age 4-5 scallops since.

## 3. Abundance Indices

Two indices of abundance are available for the Georges Bank scallop fishery, one based on the performance of the commercial fleet and a second based on the results of research vessel (RV) surveys. The fishing effort used to calculate the commercial index of abundance is expressed in terms of crew-hour-meter (crhm). It takes into account not only the number of hours fished, but also the number of crew employed and the size of the scallop dredge used. It is believed to be the index that best reflects the actual amount of fishing effort that is exerted. The commercial index of abundance follows a pattern similar to that of the catches. The index of abundance peaked in 1977 at about 1 kilogram per crew-hour-meter and declined steadily thereafter to about 0.23 kg per crew-hour-meter in 1984. The index of abundance in 1989 was almost half a kilo per crew-hour-meter.

Research surveys have been conducted since 1978 to estimate the biomass of scallops. The results suggest that recruitment has been moderate since the 1982 year-class and that survival is low after age 5. The abundance estimates of age 3 to 5 scallops in the 1987, 1988 and 1989 surveys are similar, suggesting relatively stable stock sizes for these years.

## 4. Assessment

Because it is possible (although difficult) to determine the age of sea scallops, techniques developed for finfish stocks, such as sequential population analyses (SPA), can be used to assess their abundance. These methods require that estimates of the number of scallops of each age that are caught be available for a number of consecutive years. If the number of scallops of the 1977 year-class, that is those scallops born in 1977, that were caught at age 3 in 1980 are added to the number of age 4 scallops caught in 1981 and those of age 5 caught in 1982 and so on until very few scallops of that year-class are caught (at about age 8), the sum of all the catches gives a minimum count of the numbers in that year-class. If, in addition, it is assumed that a certain proportion of the scallops died each year of natural causes, the abundance of the 1977 year-class can be adjusted accordingly in each year. Although for the oldest year-classes, it may be expected that very few scallops survive in 1989, this is not the case for the more recent year-classes. To get a good estimate of the size of those year-classes, it is necessary to estimate the proportion that was still alive in 1989. That is achieved by calibrating the sequential population analyses. The calibration of the sequential population analyses is done by comparing the trends of one or several indices of stock size such as commercial catch per unit of effort (CPUE) or research vessel survey population estimates with the trends of SPA population estimates when various estimates of fishing mortality in 1989 are tried in the calculation. The fishing mortality that provides the best agreement between the trends of SPA and those of the abundance indices is then selected.

For Georges Bank scallops, both the commercial CPUE and the research vessel survey biomass are used as indices of abundance to calibrate the SPA. The natural mortality rate is estimated to be M=0.10. The best results were obtained with a fishing mortality of F=0.14 for the last quarter of the year which results in a fishing mortality of about F=0.40 for the year 1989. The results of the assessment are shown in Figure 2 and they indicate that the fishing mortality has been relatively stable since 1983. The biomass was at a maximum in 1977 at about 23,000 t, declined to about 7,500 t in 1984 and has recovered since to about 11,000 t in 1989, having been relatively stable since 1986-87. In this period, the 1972 and 1973 year-classes were the largest in the series at more than 2 billion scallops while annual recruitment since 1982 has been about 500 million scallops or less.

## 5. Prognosis

Catch projections were made assuming that recruitment in 1990 would be equal to the average of recent levels, that is about 400 million scallops. Fishing at $F_{0.1}$ would imply catches of about 3,300 t while fishing at $F_{max}$ would imply catches of about 4,800 t. CAFSAC notes that these catch projections assume that the age and temporal distributions of the catch in 1990 would remain similar to the recent past.

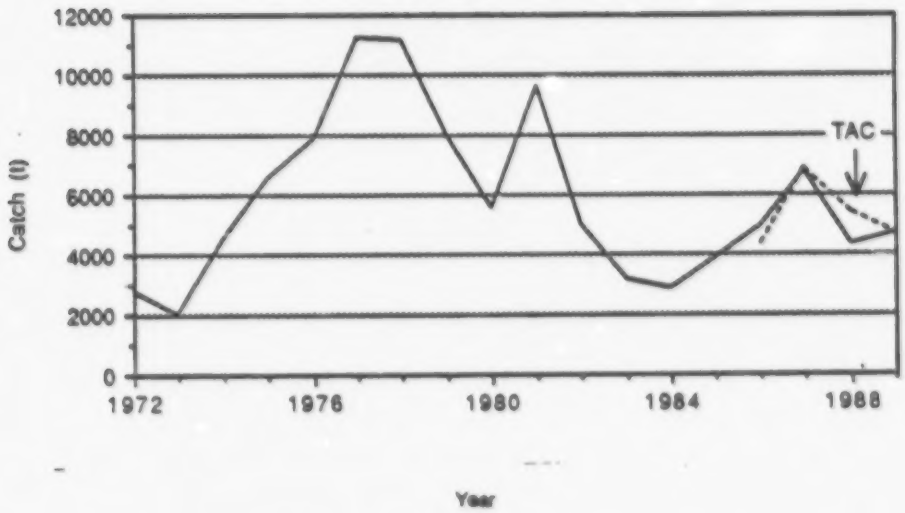


Figure 1. Catch and TAC profile for Georges Bank scallops.

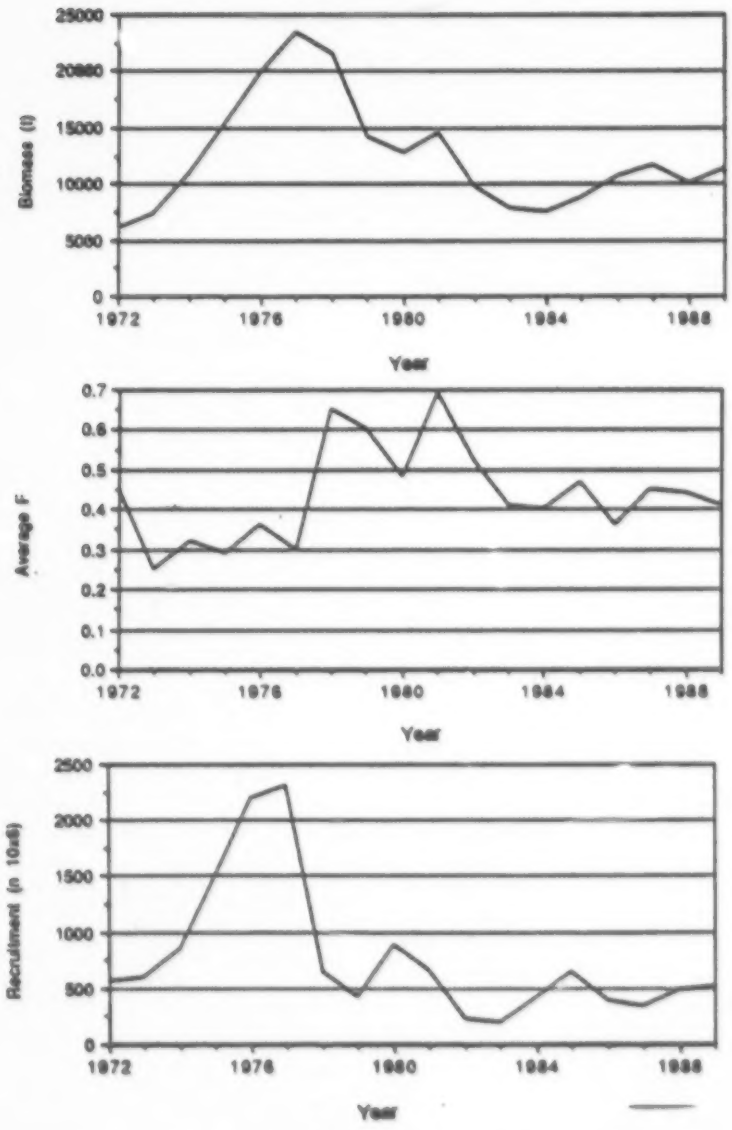


Figure 2. Biomass in tons, average fishing mortality and recruitment in millions for Georges Bank scallops.

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Advisory Document 90/4

# Advice on the Management of Herring Stocks on the Atlantic Coast of Canada for 1991

This document provides biological information on the status of herring stocks on the east and southeast coasts of Newfoundland, those in NAFO divisions 4R, 4S, 4T, in Subdivision 4Vn, in divisions 4WX and in Division 5Z.

## GENERAL INTRODUCTION

### Herring Biology

Herring in the Canadian Atlantic generally occur as a mixture of one or more stock components that spawn in the spring and of one or more components that spawn in the autumn. At spawning time, the components tend to separate from the mixed population and move towards the spawning beds, although a certain amount of spring herring may be included in catches taken near autumn spawning grounds and vice versa. Homing is not certain in the sense that it is not known to what extent herring return to spawn as adults on the exact bed on which they were born. However, adults tend to return to the same bed after they have spawned there once.

Herring off the east coast of Newfoundland have recently been assessed by acoustic surveys. Because of the large geographical area to cover and the limited ship time and staff available, not all stocks are surveyed each year. Consequently, the most recent survey for the most northern stocks was conducted in the autumn of 1988. For the southern stocks, surveys were conducted during the winter of 1989-1990. Target strength estimates are used to translate sound intensity recorded during acoustic surveys into weight units to estimate the biomass present. In recent years, CAFSAC has used target strength estimates derived for herring of the eastern Atlantic but preliminary results of experiments conducted in Newfoundland suggest that this may have caused an overestimation of biomass. Should the new estimates be confirmed by further experimentation, TACs for the two southern areas would probably still be below $F_{0.1}$ while those for the northern areas would be above $F_{0.1}$. Pending confirmation of the results, catches should not exceed the largest catches in recent years.

In the Gulf of St. Lawrence, the developmental fishery in Division 4S should be closely monitored. In Division 4R, the stock abundance appears to be relatively high and the exploitation rate low although recruitment has not been good since the 1982 year-class for spring spawners and the 1979 year-class for autumn spawners. Because recruitment has not been good in recent years, stock biomass is expected to decrease and future catches should not exceed the recent maximum of 22,000 t. In Division 4T, spring spawners have recently been assessed using acoustic surveys. The labour dispute with ship's crew during the autumn of 1989 allowed only a very small coverage of the expected area of distribution and the estimates are not considered to reflect the biomass of spring spawners. The fishery seems to be exploiting several year-classes and there are indications from juvenile surveys that the 1987 year-class may be strong. There is, therefore, no reason to change the current TAC. Autumn spawners were assessed by sequential population analyses (SPA) calibrated with gillnet catch per unit of effort. Although stock size is relatively high, recent recruitment has not been good and biomass is expected to decline. The analyses are not considered sufficiently precise to warrant a change in the TAC.

On the Scotian Shelf, the 4Vn winter purse seine fishery exploits mostly herring of 4T origin, some of 4WX origin and some local herring. The fixed gear fisheries exploit mostly local herring stocks. There is not enough information to assess the local stocks and because of the stock mixing in the winter purse seine fishery, it is difficult to evaluate the impact on the 4T and 4WX herring. Results of larval surveys have been used as indices of the biomass of adult

herring in recent assessments of the 4WX herring. Detailed information on the searching and fishing operations of purse seiners have been collected since the mid-1980s and it may be possible, in the future, to calculate an index of stock size from this information. Although it has not been possible to precisely calibrate SPA, the available information indicates that the stock size increase of the early 1980s has ended and the stock may now be decreasing because there have been no strong year-classes since 1983. Catches in 1991 should not exceed the recent maximum of about 125,000 t. Georges Bank herring has recovered from its virtual extinction of the mid 1970s, but stock size does not appear sufficiently high to allow a directed fishery in 1991.

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## 1. Herring off the East and Southeast Coast of Newfoundland

### 1.1. Introduction

There are five stock areas on the east and southeast coast of Newfoundland: White Bay-Notre Dame Bay, Bonavista Bay-Trinity Bay, Conception Bay-Southern Shore, St. Mary's Bay-Placentia Bay and Fortune Bay (Fig. 1.1a). Indices of abundance based on research gillnet programs are available for all five stock areas and biomass estimates for 1990 from acoustic surveys are available for St. Mary's Bay-Placentia Bay and Fortune Bay, the two southern areas. The 1982 year-class continues to be dominant in the catches of the five stock areas.

As in the previous three years, TACs were not taken in any of the stock areas in 1989 because of poor market conditions. Catches declined in three of the five stock areas and increased in Conception Bay-Southern Shore only (Fig. 1.1b). In addition to poor market conditions, purse seine fishers reported that catches declined during the autumn fishery in the two most northern areas because of mixing of substantial numbers of immature herring (primarily the 1987 year-class) with the larger commercial-sized fish. Catches in St. Mary's Bay-Placentia Bay declined since the two seiners which accounted for 60% of the total catch, changed to the more lucrative cod fishery before the herring quota was taken. The Fortune Bay fishery continued as a bait fishery only, since no purse seine vessels were licensed to fish in the areas.

TACs and landings ('000 t) for the five stock complexes for 1984-1990 are listed below:

| Stock/year | | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|---|
| WB-NDB[2] | TAC | 1.5 | 2.0 | 5.5 | 32.5 | 34.7 | 14.0 | 16.5 |
| | Catch | 1.5 | 1.8 | 2.8 | 13.5 | 7.3 | 3.4 | |
| BB-TB[2] | TAC | 0.4 | 0.8 | 3.8 | 13.7 | 16.2 | 6.9 | 23.4 |
| | Catch | 0.2 | 0.6 | 1.8 | 6.1 | 10.1 | 3.1 | |
| CB-SS[2] | TAC | 0.1 | 0.2 | 0.6 | 3.5 | 0.6 | 1.5 | 1.5 |
| | Catch | <0.1 | 0.1 | 0.2 | 1.0 | 0.5 | 1.1 | |
| SMB-PB[2] | TAC | 0.0 | 0.6 | 2.1 | 2.5 | 8.9 | 1.5 | 1.5 |
| | Catch | 0.1 | 0.1 | 0.1 | 0.3 | 1.2 | 0.4 | |
| FB[2] | TAC | 0.0 | 0.3 | 0.7 | 2.4 | 4.7 | 1.5 | 1.5 |
| | Catch | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | |

[1]Catches are preliminary
[2]WB-NDB: White Bay-Notre Dame Bay
BB-TB: Bonavista Bay-Trinity Bay
CB-SS: Conception Bay-Southern Shore
SMB-PB: St. Mary's Bay-Placentia Bay
FB: Fortune Bay

The 1982 year-class of spring spawners continued to dominate the fishery in all areas but less so than in 1988 (Fig. 1.1c). Although there were reports of the 1987 year-class mixed with schools of larger commercial-sized herring during the 1989 autumn fishery in White Bay-Notre Dame Bay, they did not contribute significantly to the catch in that area. The 1985 year-class

continued to account for approximately 20% of the commercial catch in Bonavista Bay-Trinity Bay. In the Conception Bay-Southern Shore stock complex, the 1985, 1986, and 1987 year-classes accounted for approximately 60% of the catch. The commercial catch in the two southern areas was similar to that in 1988 when the 1982 year-class dominated the catch. Other than the modest contribution of the 1985 year-class in the two northern areas, the age structure of commercial catches in 1989 indicates that there have been no strong year-classes coming into these stocks since 1982.

## 1.2. Abundance Indices

### Research Gillnets

The research gillnet program was continued for the tenth consecutive year during the autumn along the northeast coast, for the eighth year during the spring along the southeast coast, and for the fifth consecutive year during the spring along the northeast coast. The research gillnet fishers were contracted to fish five gillnets (mesh sizes 2"-3") for one month, to maintain an accurate daily log record of their catches, and to collect samples of their catch. In the spring program, the 1982 year-class again dominated by number in all areas. As in the commercial fishery, the 1985 year-class was evident in both Bonavista Bay-Trinity Bay and Conception Bay-Southern Shore. In Fortune Bay, year-classes subsequent to 1982 continued to be absent from the research gillnet catches, which is consistent with observations from the commercial fishery in the area. There is evidence of substantial recruitment of the 1987 year-class to the research gillnets in Bonavista Bay-Trinity Bay and Conception Bay-Southern Shore during the autumn program in 1989. A larger catch of two-year-old fish in the south is not unexpected as fish growth, and hence selection to the research gillnets, increases from north to south. Further evidence of the strength of this year-class will be available from the 1990 spring research gillnet catches.

The research gillnet data base was expanded this year to include some areas where data were collected during the spring in 1970, 1971, 1973, 1980, 1981, and 1982. These data collected during research cruises of the 1970s and early 1980s, are not directly comparable to the present research gillnet data as the nets used were "shallow" nets identical to those fished by contract fishers from 1980-1982. The same conversion factor (2.75), derived from comparisons of catches from deep and shallow nets which has been used to adjust shallow net catches of contract fishers, was used to adjust the shallow net catches for the 1970-1982 research data.

The catch rates increased in 1989 compared with 1988 in White Bay-Notre Dame Bay and Fortune Bay for the spring series and in White Bay-Notre Dame Bay only for the autumn series (Fig. 1.1d). Catch rates generally decreased in the other areas.

Purse seine catch rates have been shown to be influenced by a number of factors that do not necessarily reflect changes in stock size, size of nets and water depth fished.

**Acoustic Surveys**

Biomass estimates for the three northern stock areas, White Bay-Notre Dame Bay, Bonavista Bay-Trinity Bay, and the Conception Bay portion of Conception Bay-Southern Shore came from an acoustic survey conducted during the autumn of 1988. Biomass estimates for the two southern areas were derived from a cruise conducted during the winter of 1990. Results of the 1988 survey for the northern areas showed the 1982 year-class as dominant followed by the 1985 and 1987 year-classes. The 1990 survey also showed the spring 1982 year-class as important in the two southern areas but the 1987 year-class is dominant in Fortune Bay. The available biomass estimates are presented in the table below in tons.

| Stock area | 1987 | 1988 | 1990 |
|---|---|---|---|
| WB-NDB | 135,000 | 99,000 | |
| BB-TB | 45,000 | 135,000 | |
| CB (only) | | 6,000 | |
| FB | | | 37,000 |
| SMB-PB | | | 97,500 |

The calculation of abundance from acoustic surveys is based on a relationship between the intensity of sound reflected back from fish and the quantity of fish present. The total intensity of all reflected sound can be compared from year to year and used as an index of fish abundance. In other words, if the total intensity in one year is twice that in the previous year, then it may be concluded that the abundance of fish has doubled. To translate the intensity of the reflected sound into the total weight of fish present, it is necessary to know the intensity of sound reflected by one unit of weight. This measure is called "target strength". In recent years CAFSAC has calculated total abundance using target strength information developed for herring in the northeast Atlantic and this is included in the table above. Preliminary results of research initiated in 1989 for the Newfoundland herring stocks indicate that this practice may have resulted in CAFSAC overestimating the biomass. However, these studies are not completed and a firm conclusion cannot be reached at this time.

## 1.3. Estimation of Stock Size and Forecast

Because the difference in biomass estimates depending on which target strength is used in the calculations is relatively large, CAFSAC is reluctant to provide catch projections based on biomass estimates from acoustic surveys until the studies are completed.

For the two southern areas, St. Mary's-Placentia Bay and Fortune Bay, CAFSAC notes that the 1990 precautionary TACs of 1,500 t per stock area would be below $F_{0.1}$ even if the target strength derived in 1989 on Newfoundland herring were used. For White Bay-Notre Dame Bay and Bonavista Bay-Trinity Bay however, the 1990 TAC would be above $F_{0.1}$ if the 1989 target strength is the correct one. Therefore, CAFSAC believes that catches in 1990 should not exceed the largest catches in recent years, that is 13,500 t for White Bay-Notre Dame Bay and 10,000 t for Bonavista Bay-Trinity Bay. CAFSAC plans on providing updated advice early in 1991 based on additional acoustic surveys and research on target strength.

## 2. Herring in the Gulf of St. Lawrence

### 2.1. Herring in Division 4R

#### 2.1.1. Introduction

The herring stocks in NAFO Division 4R are exploited by both fixed (gillnets) and mobile (purse seines) gear. Fishing is prosecuted by both gear sectors from April to December on both spawning and overwintering concentrations. Since 1985, the proportion of the total catch taken by the purse seines has been in excess of 80%, and reached 94% in 1989. TACs have been in effect since 1977 with regional and seasonal allocations set for each gear sector. Since 1980, 55% of the TAC has been allocated to the mobile gear and 45% to the fixed gear.

Total reported landings have ranged from a low in 1969 of 2,900 t to a high of 27,000 t in 1973, mainly because of fluctuations in the size of the purse seine fleet over that short period. Nominal catches by purse seines totalled 16,660 t in 1989 (Fig. 2.1a). Landings in the spring increased in recent years from increased over-the-side sales while those in the late autumn decreased because of exceptionally poor weather conditions. Recent TACs and total nominal catches ('000 t) were:

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 10.0 | 10.0 | 17.0 | 30.6 | 30.6 | 37.0 | 35.0 |
| Catch | 10.5 | 14.4 | 21.4 | 16.6 | 18.1 | 17.7 | |

[1]Catches are preliminary

The spring spawners have always constituted the largest proportion of the catch. This proportion has been over 80% of the catch in numbers since 1988 as the result of an active spring fishery in St. Georges Bay. The spring spawner catch has been dominated by the 1968, 1974 and more recently the 1980 and 1982 year-classes which in 1989, constituted 27% and 47% of the catch in numbers, respectively (Fig. 2.1b). The autumn spawner catch had been dominated by the 11+ age group until 1981. More recently, the 1979 year-class has to a large extent supported the fishery on the autumn spawners, contributing 31% of the catch in numbers in 1989.

#### 2.1.2. Abundance Indices

Indices of abundance are calculated for spring and autumn spawners separately from purchase slips and from logbooks. For both data sources, as in previous assessments, a mathematical procedure (multiplicative model) was used to take into account various factors such as the effects of changes in seasons, area of fishing, and fishers on the estimated catch per unit of effort.

The purchase slip catch per unit of effort values are available for 1981-1989 and take into account the estimated number of nets fished per day. The logbook data are supplied by index gillnet fishers hired since 1984 to complete daily logbooks recording their catch and effort as well as their location, mesh size, size of nets and water depth. All four series of catch rates generally increased until 1986-87 and then decreased. The spring and autumn catch per unit of effort calculated from purchase slips increased in 1989 compared to 1988 (Fig. 2.1c) while the index gillnet fishers CPUE remained stable.

The commercial and logbook series were for the most part derived from independent data sources as the indexed fishers fished predominantly for bait.

Both commercial and logbook indices were used in the adaptive framework for the cohort analysis calibrations. The commercial series is considered useful because it represents a longer time period, while the shorter logbook series is believed to give a more precise view of catch rates in the most recent years. Purse seine catch rates have been shown to be influenced by a number of factors that do not necessarily reflect changes in stock size and they were not considered in this assessment of the size of Division 4R herring stock.

### 2.1.3. Estimation of Stock Size and Forecast

An analytical assessment of the stock size using the ADAPT technique was not possible because fishing mortalities were generally too low and sequential population analyses did not converge. CAFSAC notes that recent catches in the range of 14,000 t to 22,000 t appear to have resulted in relatively low fishing mortalities. These catches were largely dependent on the strong 1982 year-class and CAFSAC suggests that 1991 catches should not exceed the recent maximum of 22,000 t since there appears to have been no significant recruitment after the 1982 year-class.

## 2.2. Herring in Division 4S

### 2.2.1. Introduction

There was a limited commercial fishery on this stock in 1989 and the resulting lack of data precludes an analytical assessment of the stock complex. However, as in previous years, available landings from the fisheries in the eastern and western regions of 4S are presented separately, the separation being at longitude 62°55'.

Herring landings from Division 4S in 1989 totalled 538 t partitioned almost equally between east and west. TACs and landings for Division 4S from 1984 to 1989 are presented below (t) and since 1975 in Fig. 2.2:

| | 1984[1] | 1985[1] | 1986[1] | 1987[1,2] | 1988[2] | 1989[2] | 1990[4] |
|---|---|---|---|---|---|---|---|
| TAC[3] (west) | | | | | 1,500 | 1,500 | |
| TAC[3] (east) | 1,000 | 1,000 | 1,000 | 1,000 | 2,000 | 2,000 | |
| Total[3] | 1,000 | 1,000 | 1,000 | 1,000 | 3,500 | 3,500 | 4,000 |
| Landings (west) | 224 | 190 | 224 | 577 | 601 | 265 | |
| Landings (east) | 736 | 335 | 493 | 854 | 329 | 273 | |
| Total landings | 960 | 525 | 717 | 1,431 | 930 | 538 | |

[1]No TAC set because of possible relationships with 4T herring.
[2]Catches are preliminary
[3]Precautionary
[4]TAC not split east-west

In western 4S, the landings increased steadily from 190 t in 1985, to 601 t in 1988, before declining to 265 t in 1989. The eastern 4S landings decreased further to 273 t in 1989 from an historical high of 854 t in 1987, entirely because of market constraints.

### 2.2.2. Estimation of Stock Size and Forecast

CAFSAC has previously advised (Advisory Document 87/18) that "because of the possibility of intermingling between the Division 4S stocks and those of adjacent

divisions, and the biological problems inherent in fishing mixed stocks, a better understanding of this stock complex is required before the significance of any increase in the commercial fishery can be evaluated." CAFSAC reiterates its belief that the present controls be adhered to and that the recent increase in fishing effort be accompanied by close biological monitoring.

## 2.3. Herring in Division 4T

### 2.3.1. Introduction

During 1949-1964, the average landings in Division 4T of both spring and autumn spawners combined were about 32,000 t and the fishery was primarily by gillnetters on spawning grounds. In the mid-1960s, purse seines were introduced and catches in Division 4T increased rapidly to a peak of 175,000 t in 1970 (Fig. 2.3a). However, in the late 1960s-early 1970s catches of Division 4T herring were made in other areas, particularly in Division 3P. Overall, it is estimated that catches of Division 4T spawned herring peaked at about 270,000 t in 1970. Purse seines remained the major gear throughout the 1970s but as total catches declined, the dominance of this gear type decreased. During 1981-85 the total catch in Division 4T varied between 21,000 t and 31,000 t, increased to 77,600 t in 1987, and decreased to 71,400 t in 1988 and to 56,800 t in 1989.

The purse seine fishery in the early 1970s exploited a very large biomass of both spring and autumn spawners from two extremely large year-classes born in the late 1950s. The combined spawning biomass peaked in the mid-1960s, declined steadily through the 1970s and by 1981 was less than 10% of maximum levels. Since then, the spawning biomass has increased, partly in response to better recruitment but also because of catch controls.

The fisheries have been under TAC regulation since 1975, with allocations to different gear sectors becoming more complex over time. The 1989 TAC was 86,904 t divided as follows: 16,800 t for the spring gillnet fishery; 52,854 t for the autumn gillnet fishery; and 17,250 t for the autumn purse seine fishery. Total 1989 landings were 56,847 t, which is below the 1986-1988 landings but greater than those of the period 1974-1985. This decline in catches was a result of low market prices. Recent reported nominal catches and TACs are provided below ('000 t):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 19.0 | 32.2 | 43.4 | 72.8 | 78.9 | 86.9 | 91.0 |
| Catch | 24.0 | 34.0 | 59 | 77.6 | 71.4 | 56.8 | |

[1]Catches are preliminary

Over the past decade, three administrative regions and several biologists/scientists have been directly involved in the 4T herring assessment; several methods have been used to determine the spawning type assignments and these have not always been consistently applied. These factors have introduced inconsistencies in the data sets which have complicated the interpretation of past assessments and the comparison of assessments performed in different years.

Since the 1989 assessment, progress has been made in reconciling these data. The files have been carefully edited, the landings have been updated for area, gear-type and time, and the spawning groups have been assigned by the same methodology for each year. The greatest change resulted from the correction of data files and it resulted in a modest increase in population size estimates. Overall CAFSAC is confident that the consistency of the 4T herring assessments will be enhanced as a result of these improvements to the input data.

The catches in the different fisheries include some herring from both spring and autumn spawning components although the gillnet fisheries, which take maturing herring, are dominated by one type or the other according to the season. The purse seine catches, whether made in the autumn, or in the spring, harvest a mix of the two spawning types; the actual contributions of each varying from year to year. The catch of autumn spawners has been greater than that of spring spawners since 1974. During the 1980s, the catch composition has been about 70% autumn spawners and 30% spring spawners. The 1989 age composition of the catch is showed in Fig. 2.3b.

2.3.2. Abundance Indices

Information on abundance of herring in Division 4T is available from the commercial gillnet fishery and from an acoustic survey. Purse seine catch rates have been shown to be influenced by a number of factors that do not necessarily reflect changes in stock size and they were therefore not considered in this assessment of the size of Division 4T herring stock.

**Commercial Catch Rates**

Information on commercial catch rates in 1989 was collected in the same manner as in recent years. Gillnet catch per fishing trip for the five main fishing areas was calculated from purchase slips. This was used to estimate catch per net fished on the basis of the number of nets used per trip in each area as reported in questionnaire surveys of fishers. The 1989 survey indicated that there had been an increase in the number of nets used in the spring fishery from 19.9 nets in 1988 to 26.6 nets in 1989. There was no change in the number of nets used in the autumn fishery. The mesh size distribution does not appear to have changed in either the spring or the autumn fishery for the period 1985-1989.

The procedure for combining the catch rate information from the different fishing areas into an overall catch rate was examined using a multiplicative model which allowed geographic and seasonal patterns to be investigated.

For the autumn spawners, the analyses of purchase slip data (Fig. 2.3c) suggest that there has been a gradual increase in catch per unit of effort during 1986 to 1989.

For the spring spawners there is a decline between 1988 and 1989 in catch per unit of effort from the purchase slip information (Fig. 2.3c), but the values for 1987 to 1989 are not statistically different from one another. The purchase slip information suggests that spring spawning herring have generally been more abundant during 1987 to 1989 than during 1979 to 1983.

**Acoustic Surveys**

An autumn acoustic survey for Division 4T herring has been conducted since 1984, but the survey was changed in 1989 to follow a stratified random design. Normally, this survey covers the Chaleur Bay and Sydney Bight areas in the first and second halves of November respectively, but because of a labour dispute, only the Chaleur Bay area was surveyed in 1989 and only for a 30 hour period compared to the usual five days.

The results suggest a decrease in biomass from 240,000 t in 1988 to 11,000 t in 1989. CAFSAC believes that this change in estimated biomass between 1988 and 1989 is likely because herring are in areas other than those surveyed rather than reflecting a real change in biomass between the two years.

Acoustic biomass estimates for the 1989 and from previous surveys are given in the table below ('000 t):

| | Chaleur Bay | | | Sydney Bight | | |
|---|---|---|---|---|---|---|
| | Spring spawners | Autumn spawners | Total | Spring spawners | Autumn spawners | Total |
| 1984 | - | - | 105 | - | - | 76 |
| 1985 | - | - | 74 | - | - | 107 |
| 1986 | 143 | 113 | 256 | - | - | 128 |
| 1987 | 154 | 563 | 717 | 192 | 251 | 443 |
| 1988 | 164 | 76 | 240 | 48 | 125 | 173 |
| 1989 | - | - | 11[1] | -[2] | -[2] | -[2] |

[1]Believed to be an underestimate
[2]Sydney Bight not surveyed because of a labour dispute

2.3.3. Estimation of Stock Size and Forecast

**Spring Spawners**

The commercial catch per unit of effort of the 4T herring spring spawners is suspected of being influenced more by availability of markets than by herring abundance. Therefore, there are limited data available on which to base the calibration of sequential population analyses. In addition, as indicated above, the 1989 acoustic survey is not considered indicative of stock abundance. CAFSAC has no information which would invalidate the analyses supporting the 1989 assessment (CAFSAC Adv. Doc. 89/11) which indicated that recent fishing mortality has been close to $F_{0.1}$ with the fishery exploiting several year-classes. In addition, there are indications from juvenile surveys that the 1987 year-class may be strong. There is, therefore, no reasons to change the current TAC.

**Autumn Spawners**

As was done in recent assessments, the age-specific availability of herring to the gillnet fishery was determined through calibration of the SPA with gillnet catch rates at age using the ADAPT.

The results suggest that the age 5 and older biomass has remained stable between 1988 and 1989 (Fig. 2.3d). The estimated fishing mortality in 1988 is slightly lower in the present assessment when compared with last year's because of the revision of the catch-at-age matrix mentioned in the introduction to this assessment.

The following 1989 input parameters were used to calculate catch projections:

| Age | Numbers (x 1000) | Catch (x 1000) | Weight[2] (kg) | PR[3] |
|---|---|---|---|---|
| 2 | 391,846[1] | 684 | 0.102 | 0.01 |
| 3 | 321,314[1] | 859 | 0.202 | 0.04 |
| 4 | 252,312 | 14,868 | 0.256 | 0.34 |
| 5 | 242,695 | 24,842 | 0.289 | 0.49 |
| 6 | 271,895 | 30,633 | 0.320 | 0.67 |
| 7 | 131,117 | 16,033 | 0.345 | 0.98 |
| 8 | 58,787 | 10,477 | 0.350 | 1 |
| 9 | 69,726 | 10,955 | 0.370 | 1 |
| 10+ | 42,236 | 7,596 | 0.395 | 1 |

[1]Derived from geometric mean at age 2, 1978 to 1987
[2]1989 values
[3]Calculated using two-way ANOVA for 1986-88 excluding ages 9 and 10

The results of the projections are given below. As of early October, 1990, it is expected that 1990 autumn spawners catch by fixed gear and purse seine will be about 53,700 t.

| | 1990 | 1991 |
|---|---|---|
| Catch | 53,700 | 47,000 |
| 5+ Biomass (t) | 197,000 | 170,000 |
| Fully Rec. F | 0.31 | 0.30 |

CAFSAC notes that the biomass of age 5 and older herring appears relatively high, although decreasing slightly in 1990 and indications are that recent recruitment is about average. CAFSAC does not have sufficient evidence to advise a TAC for 1991 different from the 1990 TAC.

## 3. Herring on the Scotian Shelf and in Division 5Z

### 3.1. Herring in Subdivision 4Vn

The 4Vn herring fishery has two components. A relatively small (less than 500 t per year) trap and gillnet fishery has historically taken place near shore and in the Bras d'Or Lakes during the spring and summer and is presumed to harvest local stocks. A large vessel mobile fishery began in 1968. It was dominated by foreign vessels for the first two years, but subsequently has been almost exclusively a Canadian purse seine fishery operating during late autumn and early winter months. In recent years this fishery has been restricted to the northern part of 4Vn (north of Pt. Aconi) where it is considered to exploit overwintering herring from several stocks, but primarily from Division 4T. Annual landings peaked at 17,547 t in 1972-1973 but, with TAC regulation have been less than 5,000 t since 1978 (Fig. 3.1a). Recent TACs and landings are as

follows ('000 t):

| | 84-85 | 85-86 | 86-87 | 87-88[1] | 88-89[1] | 89-90[1] | 90-91 |
|---|---|---|---|---|---|---|---|
| TAC | 3.5 | 3.5 | 4.2 | 4.2 | 4.2 | 4.2 | |
| Catch (inshore) | 0.2 | 0.1 | 0.1 | 0.3 | 0.1 | | |
| Catch (purse seine) | 3.9 | 3.5 | 4.4 | 2.4 | 2.6 | 2.1 | |
| Total | 4.1 | 3.6 | 4.5 | 2.7 | 2.7 | | |

[1]Catches are preliminary

The 1989-90 purse seine fishery took place between November 27 and December 7, 1989. Total reported landings amounted to 2,078 t, a reduction of almost 500 t from 1988 and the lowest in 20 years. As in recent years the fishery was concentrated along the north shore around Cape Smokey. The 1983 year-class (age 6) again dominated the purse seine catch (Fig. 3.1b) in both number (32.5%) and weight (33.5%). The 1989-90 purse seine catch rate (Fig. 3.1c) is about equal to the average of the last 5-6 years.

A review of herring tagging results in 4TVWX was conducted taking into account the relative abundance in 4T and 4WX. The conclusions reached previously remain unchanged that is:

1. during the period 1977-1980, 4Vn was an overwintering area for at least some 4T and some 4WX herring;

2. of releases made in northern 4Vn, the predominance of returns was from 4T;

3. of releases made in southern 4Vn, the great majority of returns came from 4Wa, with fewer returns from 4X and 4T in the ratio of approximately 2:1; and

4. many fish tagged in 4Vn during the winter were recovered in 4Wa.

CAFSAC notes that the 4WX and 4T herring stocks and their fisheries have changed in size and distribution since the time of these studies, and therefore the conclusions may or may not pertain to the present situation.

CAFSAC has not changed its view of 4Vn herring stock structure. The summer fixed gear fishery is considered to exploit local stocks, and the winter purse seine fishery is on a mixture of stocks. Although regulatory restriction of the fishery to the northern part of 4Vn undoubtedly increased the 4T and decreased the 4WX contribution to the catch, CAFSAC cannot precisely quantify the appropriate proportions from existing tagging data. CAFSAC reiterates that there is insufficient information to assess the local stocks supporting the inshore fishery and that because of stock mixing in the winter fishery an analytical assessment of 4Vn is not possible.

## 3.2. Herring in Divisions 4WX

### 3.2.1. Introduction

Catches from this stock increased rapidly in the 1960s, to 196,000 t in 1968, because of the development of the fish meal industry and the corresponding expansion of the purse seine fleet (Fig. 3.2a). Subsequent catches declined irregularly through the 1970s, and with the introduction of catch controls fell to 59,000 t in 1979, before recovering to around 80,000 t. Catch statistics for 1973-85 are considered to have been under-reported, and adjustments have been made for the purposes of stock assessment (Advisory Document 85/16). Using these adjustments, catches were actually above 100,000 t throughout the 1970s except for 1979 (77,500 t), peaked at 136,000 t in 1984 and declined in 1985 (112,000 t) and 1986 (74,000 t). This reduction in catch appeared to reflect a decrease in

the market for products other than roe, and in 1986, a decrease of approximately 9,000 t in over-the-side sales to foreign vessels. The catch recovered in 1988 to 124,600 t before declining to 84,500 t in 1989.

The predominant fishing method is by purse seine, followed by weirs, gillnets, traps, shutoffs and midwater trawls. The catch by some of these fishery components is considered to be herring from stocks other than from the main divisions 4WX stock complex and are referred to as non-stock fisheries. Thus catches by weir and shutoffs along the New Brunswick coast of the Bay of Fundy, and by inshore gear along the Nova Scotia coast east of Queens County are not counted against the TAC. Recent TACs and total catches in divisions 4WX are given below ('000t):

| | 1984 | 1985 | 1986 | 1987[3] | 1988[3] | 1989[3] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 80.0 | 125.0 | 97.6[2] | 126.5 | 151.2 | 151.2 | 151.2 |
| Stock catch[1] | 135.9 | 112.4 | 73.7 | 101.2 | 124.6 | 84.5 | |
| Total catch 4WX | 88.7 | 141.9 | 101.8 | 130.2 | 159.9 | 129.4 | |

[1]1984-85 include adjustments for misreporting.
[2]Excludes an allowance of 13,000 t for inshore Div. 4X fixed gear.
[3]Catches are preliminary

The 1989 Scotia-Fundy Region Herring Management Plan established quotas of 132,450 t for the purse seine fleet and 850 t for midwater trawl. In addition, an allowance of 17,900 t was made for catches by "inshore" components (gillnets, Nova Scotia weirs, Nova Scotia traps) for a TAC of 151,200 t. As in previous years, the New Brunswick weir and shutoff fishery, considered to rely on non-stock fish of Gulf of Maine origin, were excluded from the TAC. As in 1988, the plan allowed a small experimental roe fishery in the upper Bay of Fundy with the opening date to be determined by roe yield observed in test sets. This roe fishery did not develop (because of market problems) but approximately 6,500 t were taken from the upper Bay of Fundy for other markets. In a continuing effort to decrease the fishing pressure on the Trinity Ledge spawning component, the plan imposed intermittent closures of a 100 square mile area around the ledge for a total of 18 days during August and September.

As in recent years, the 1989 herring fishery in NAFO Division 4WX was dominated by a purse seine fleet of 40 vessels which accounted for 95% of the landings. The remaining landings came from approximately 250 weirs, a single midwater trawler, gillnetters, shutoffs, and traps. The largest fishery took place on prespawning and spawning aggregations off southwest Nova Scotia (4X; June-October), but there were also major fisheries off southern New Brunswick and off Cape Breton (4W Chedabucto Bay; October-January). The fishery continued to be influenced strongly by markets, but was dominated in 1989 by landings of adult (fillet) fish to domestic processors and the over-the-side sales to foreign vessels, rather than by the roe market.

The 1983 year-class again dominated major stock fisheries (Fig. 3.2b) in number (27%) and weight (37%). Age 2 fish (1987 year-class) were again dominant in the non-stock fisheries and age 3 in the 4X autumn-winter purse seine fishery on the New Brunswick side of the Bay of Fundy.

### 3.2.2. Abundance Indices

#### Commercial Catch Rates

Logbook information was available for 94% of the catch in the summer purse seine fishery. Total fishing effort decreased compared with 1988 in response to depressed markets. The decreased fishing effort was well distributed on all fishing grounds except on Trinity Ledge where catch and effort decreased substantially. Fishing effort increased on the Long Island Shore, Seal Island

and in the upper Bay of Fundy. Very detailed information is collected from this purse seine fishery and CAFSAC hopes to be able to test whether such additional information may help make catch and effort data from purse seines useful as indicators of abundance.

**Research Surveys**

In 1989, CAFSAC reviewed the larval survey data that has been used as an index of spawning stock size for this stock and concluded that the historic index (arithmetic mean of 79 stations surveyed annually) was adequate and did not require mathematical transformations. The 1989 survey was conducted between October 23rd and November 9th. All 79 of the traditional larval abundance index stations were sampled. The resulting index was approximately 40% below the 1988 index point, but is the second highest in the 18 year time series (Fig. 3.2c).

An acoustic survey has been conducted in January since 1984, but the design was changed to stratified random in 1989. The results suggest a biomass of about 190,000 t, substantially less than the 450,000 t reported for January 1989 (Fig. 3.2d). Neighbouring areas were searched but no herring were found. In 1990, herring were not concentrated close to shore as was observed in 1989. Anecdotal information indicates that herring may have left Chedabucto Bay early in 1990. Fishers claim that herring had been more prevalent in December, but that due to the severe winter, January appeared more like a typical February and that herring had already left the bay.

A new index, based upon the by-catch of herring in research groundfish surveys was calculated. Surveys of 4WX have been conducted in the past in spring, summer and autumn, but only the summer survey has a long and ongoing time series. Herring by-catch was calculated as numbers per standardized tow weighted by stratum area. Further work is required to evaluate fully the usefulness of this index as an indicator of herring abundance.

### 3.2.3. Estimation of Stock Size and Forecast

CAFSAC was unable to complete a satisfactory analytical assessment of this stock. The existing abundance indices have been examined closely and an additional one has been developed but the analyses are not sufficiently precise to be used as the basis of catch projections. However, they reflect general trends: an increase in population size during the 1980s and recent signs of decline, which are consistent with the available indices. All abundance indices indicate that the population increase of the 1980s has ended. There is no evidence of strong year-classes in recent years and CAFSAC expects that stock size will decrease. This information suggests that catches in 1991 should not exceed recent high values, that is no more than 125,000 t.

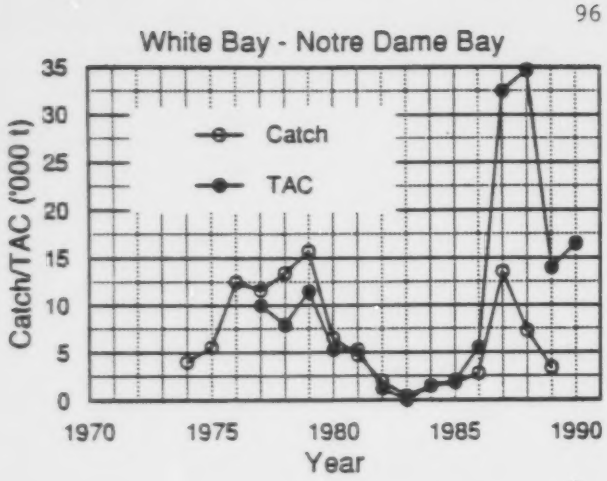
CAFSAC is concerned that very little spawning may have taken place on Trinity Ledge in 1989. This observation reinforces previous advice that fishing effort should be spread more evenly among spawning components of a stock complex. CAFSAC supports the Scotia-Fundy Herring Advisory Committee in its proposed closure of Trinity Ledge and reiterates CAFSAC's previous recommendation for a cautious approach to the development of the upper Bay of Fundy fishery.

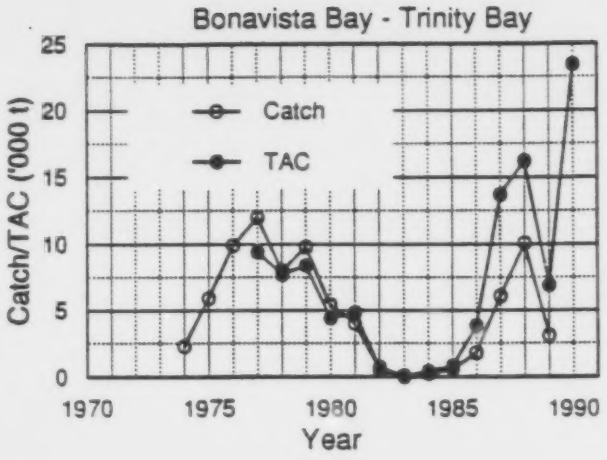
## 3.3. Herring in Division 5Z

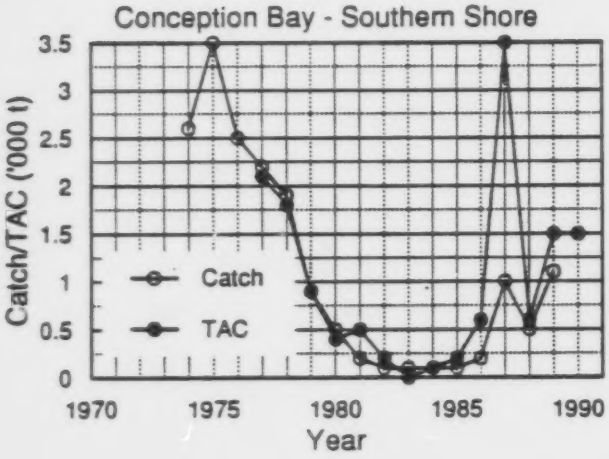
A fishery for herring on Georges Bank began in 1961 and peaked at 374,000 t in 1968 before crashing in 1977. For several years, there was virtually no sign of either adults or larvae from what had once been estimated to be the largest herring population in the northwest Atlantic. Since 1984, there has been increasing evidence from both trawl and larval surveys of a herring stock recovery on the bank. The larval survey conducted in 1989 revealed high larval abundance, particularly on the western portion of the bank, and trawl samples from the same survey suggested that while the 1986 year-class was dominant, those of 1983, 1984 and 1985 were also abundant.

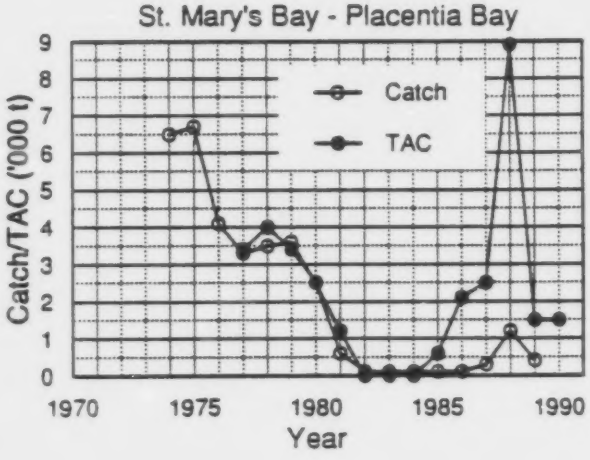
There is continued evidence for the recovery of Georges Bank herring as indicated by an increasing number of year-classes and recurrent successful spawning. However CAFSAC does not believe that this recovery is sufficient yet to support a fishery and therefore advises that there be no directed fishery for herring in Division 5Z in 1991.

Fig. 1.1a. Map showing Newfoundland herring fishing areas.



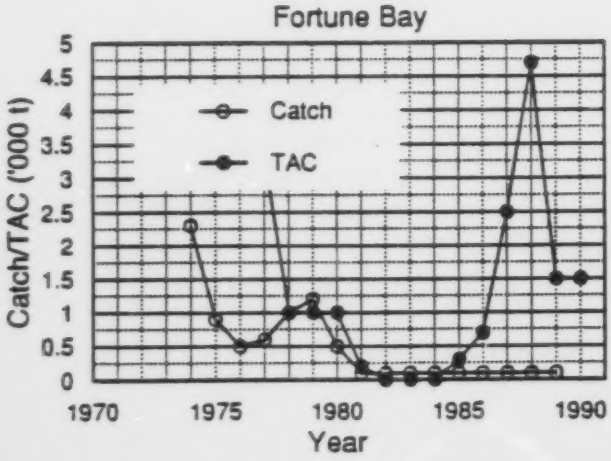




Fig. 1.1b Catches and TAC s for Newfoundland herring.

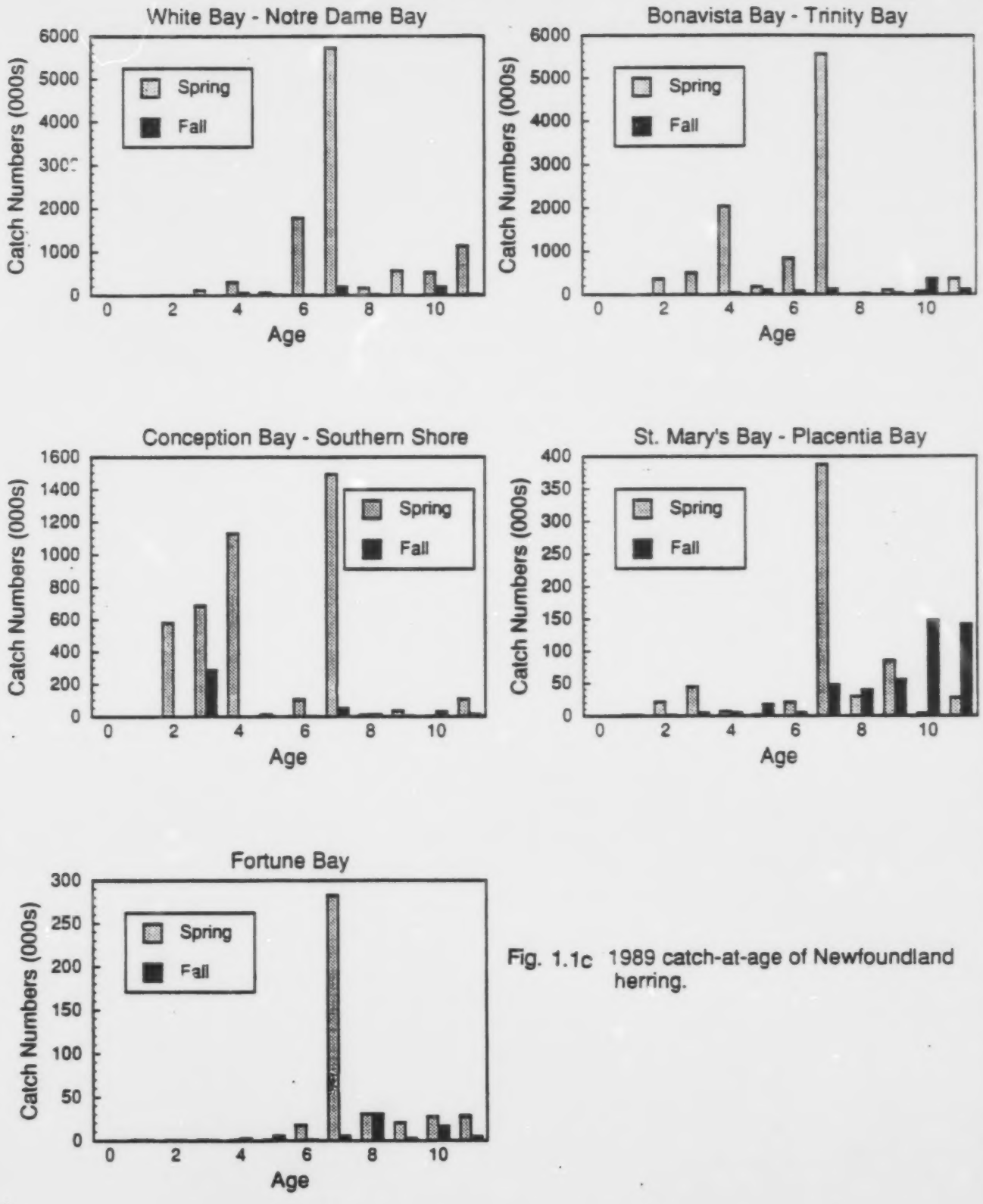



Fig. 1.1c 1989 catch-at-age of Newfoundland herring.

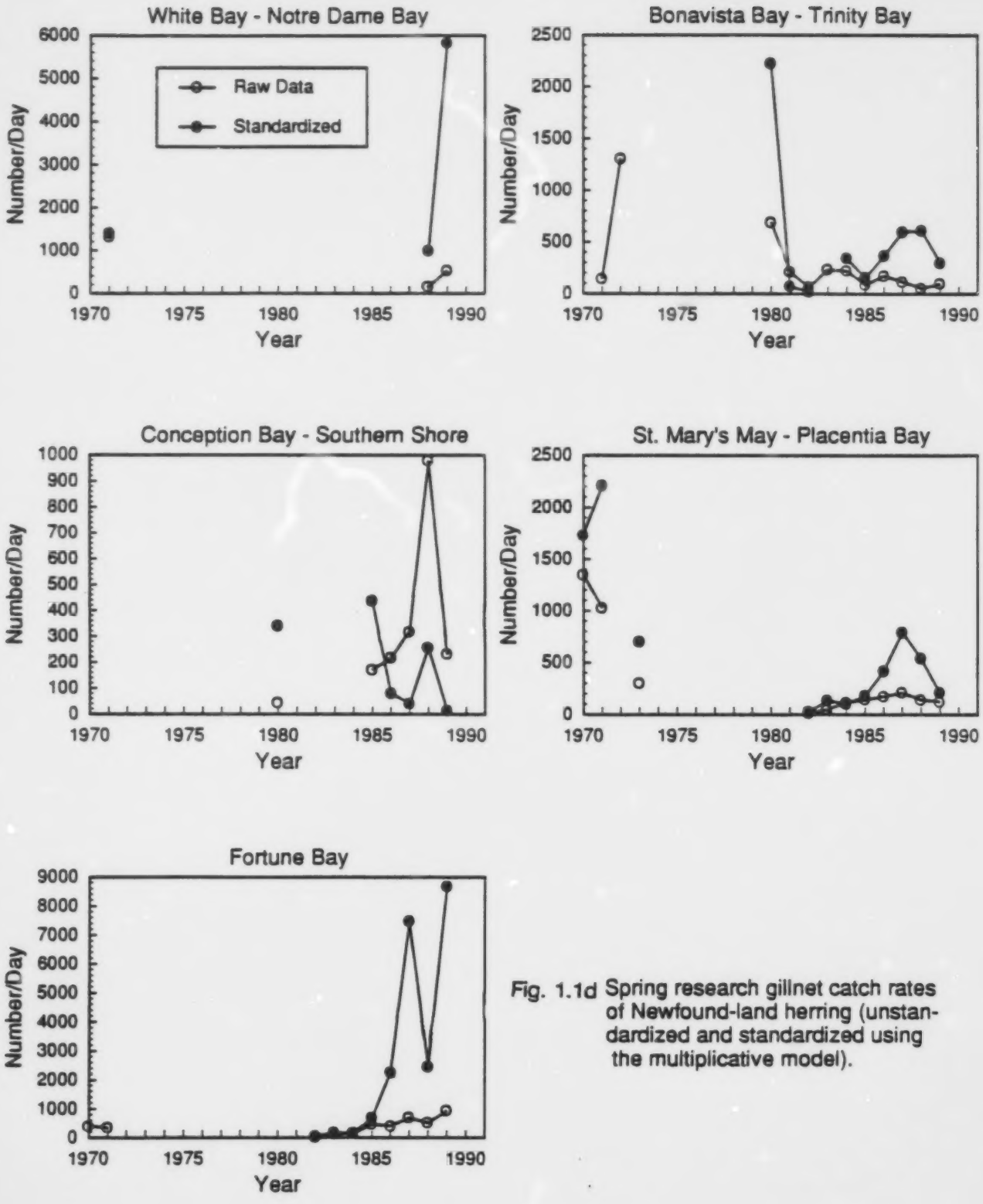
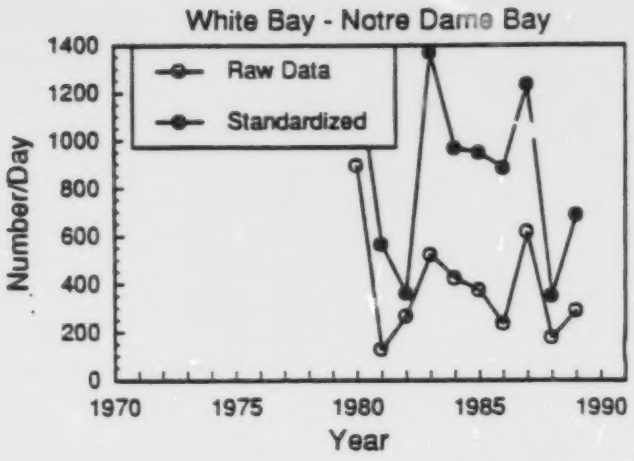
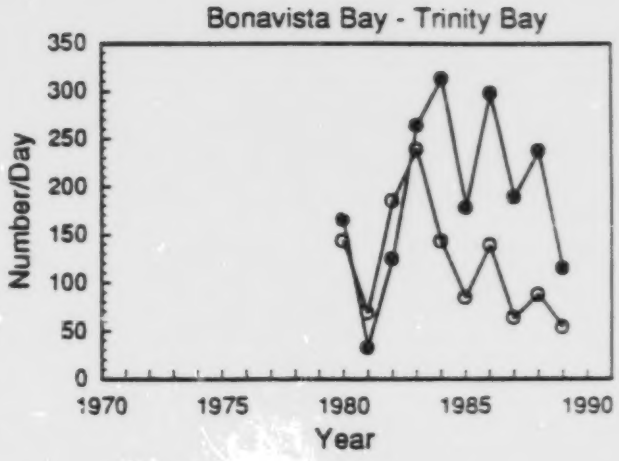



Fig. 1.1d Spring research gillnet catch rates of Newfound-land herring (unstandardized and standardized using the multiplicative model).



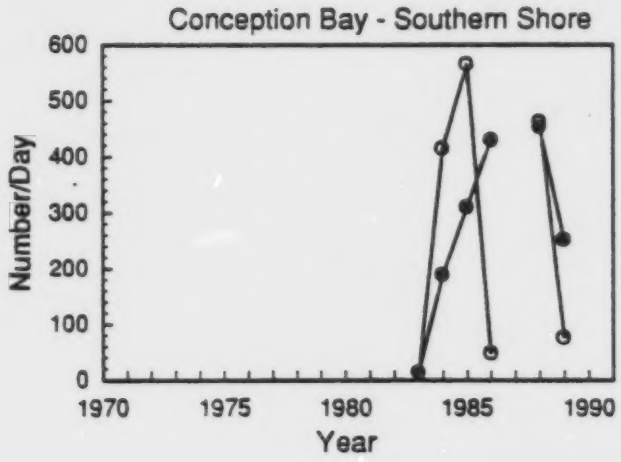




Fig. 1.1d cont.

Fall research gillnet catch rates for Newfoundland herring (unstandardized and standardized using the multiplicative model).

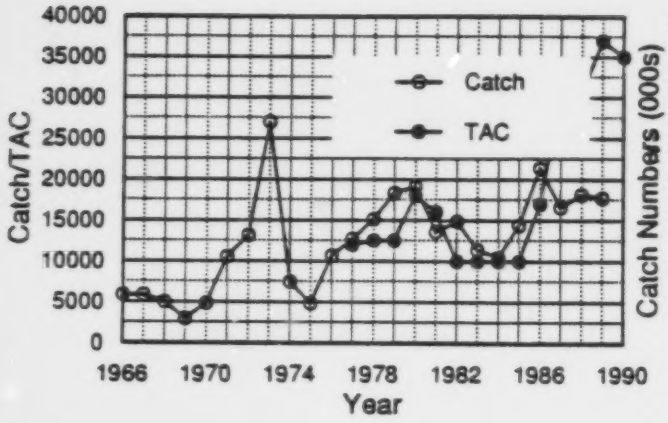



Fig. 2.1a. Catches and TACs for Div. 4R herring.

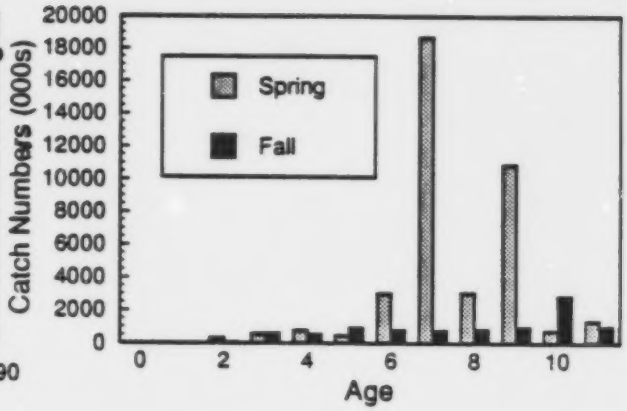
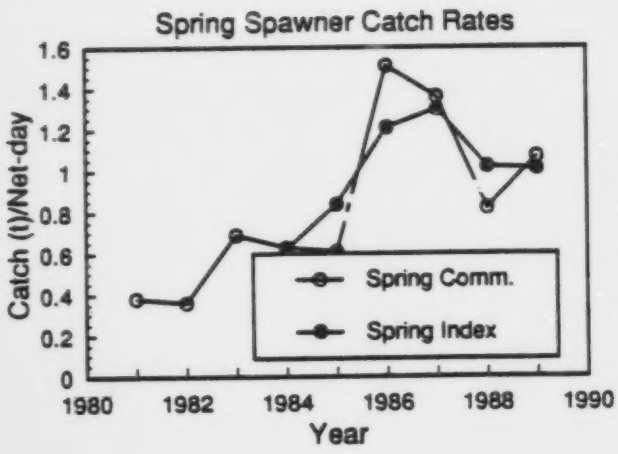



Fig. 2.1b. The 1989 catch-at-age for Div. 4R herring.



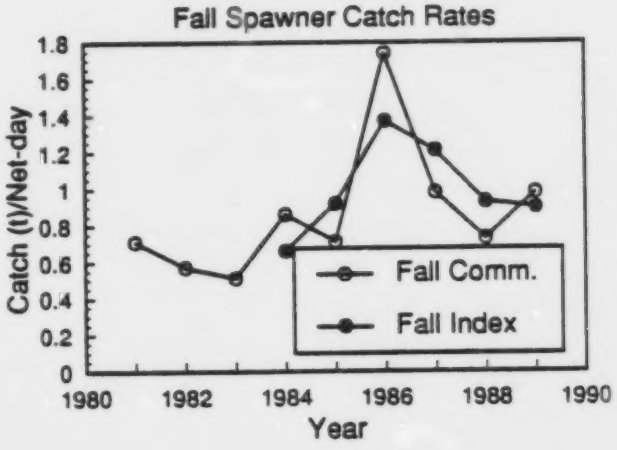




Fig. 2.1c. Spring and fall spawner catch rates for Div. 4R herring.

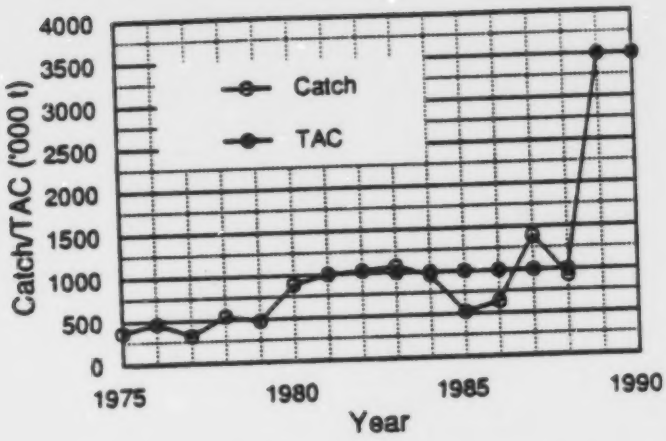



Fig. 2.2. Division 4S herring catches and TACs.

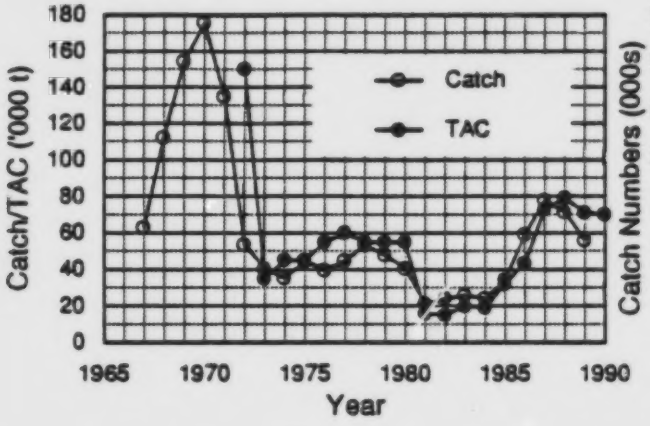



Fig. 2.3a. Division 4T catches and TACs.

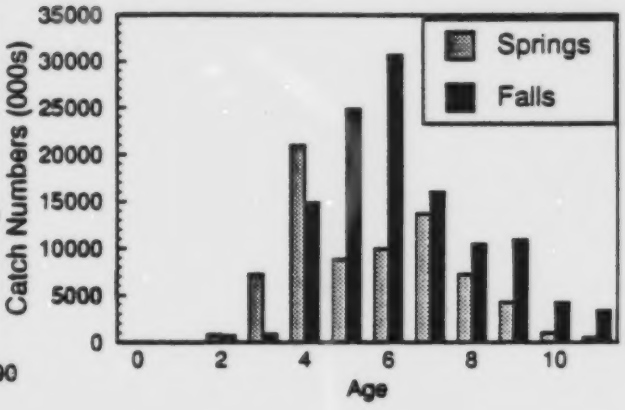



Fig. 2.3b. Division 4T 1989 catch-at-age

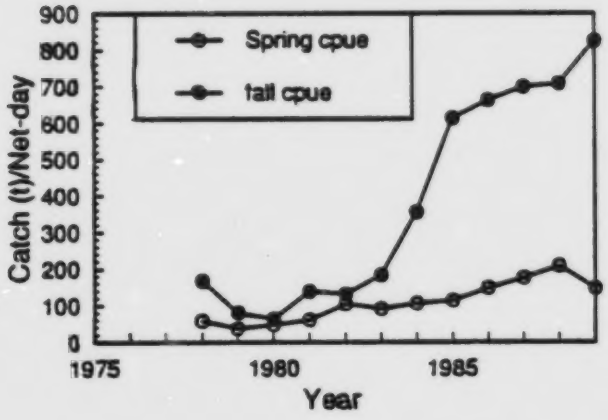



Fig. 2.3c. Division 4T gillnet CPUE.

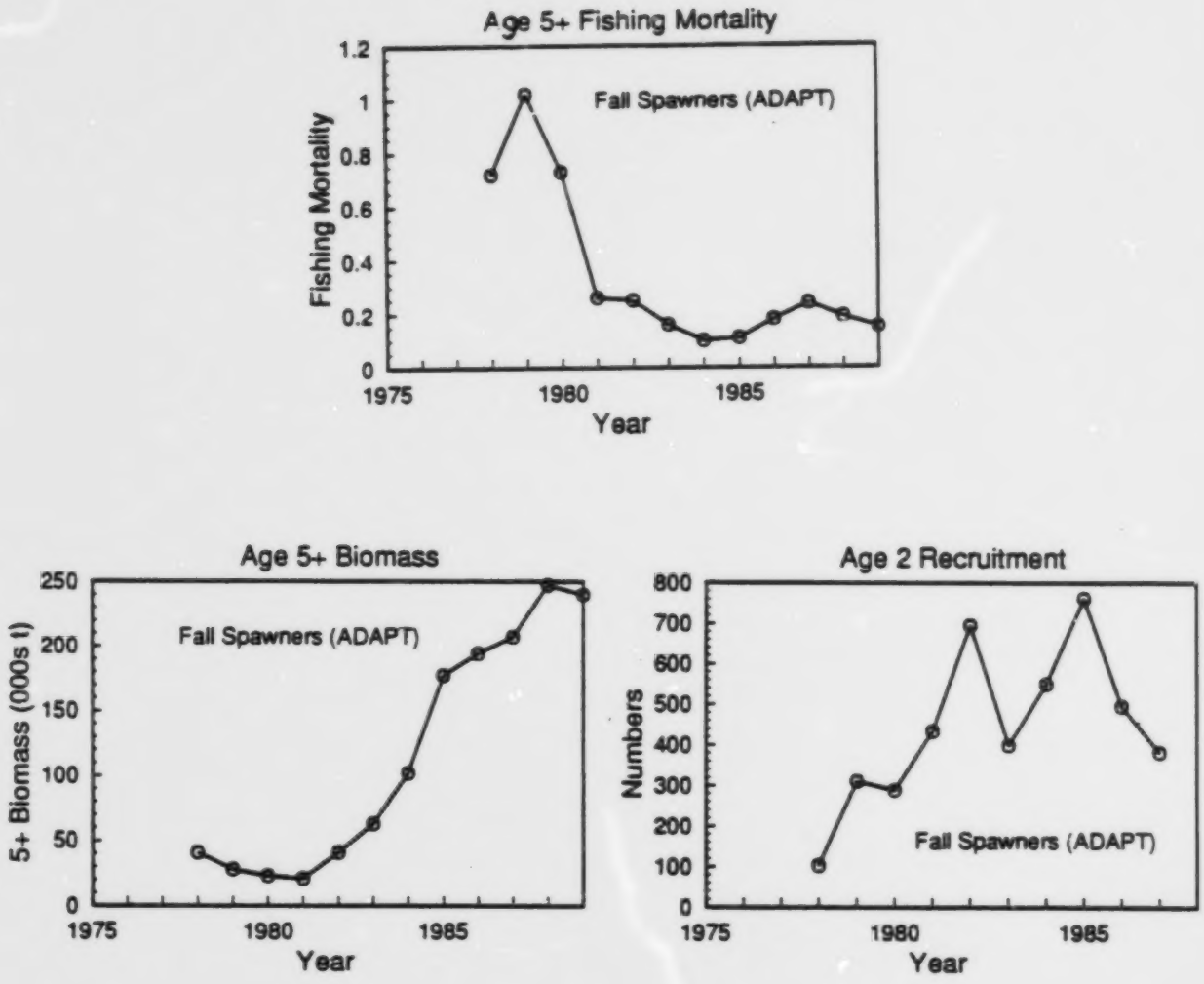



Fig. 2.3d. Division 4T fishing mortality, biomass, and recruitment.

Subdivison 4Vn Herring

Fig. 3.1a. Catches and TAC's

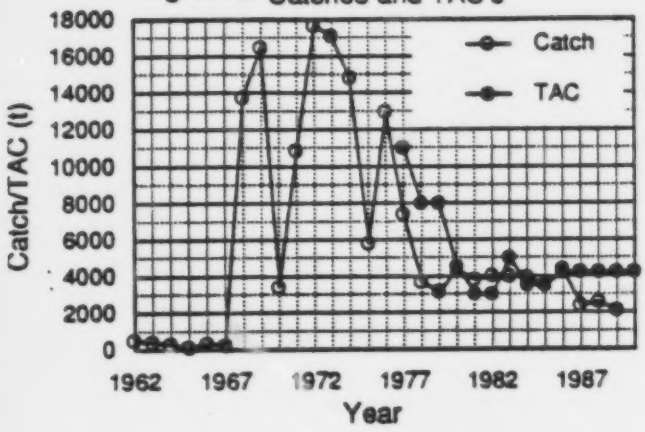



Fig. 3.1b. 1989 Purse Seine Catch-at-age

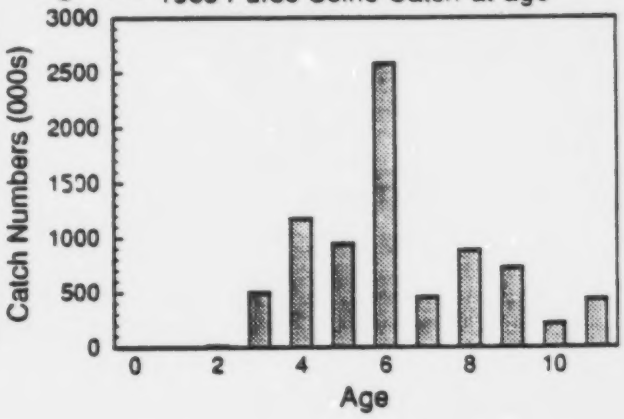
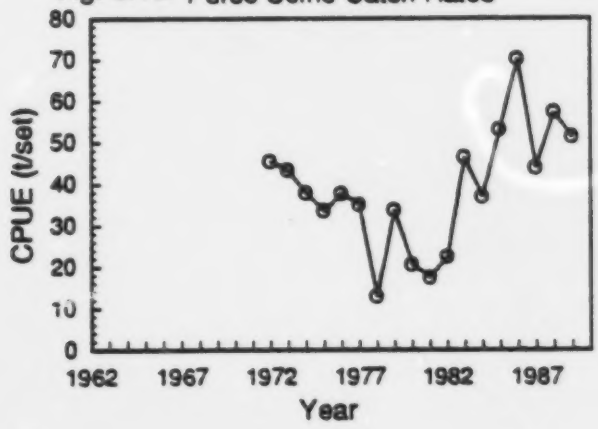



Fig. 3.1c. Purse Seine Catch Rates



## Division 4WX Herring

Fig. 3.2a. Catches and TAC's

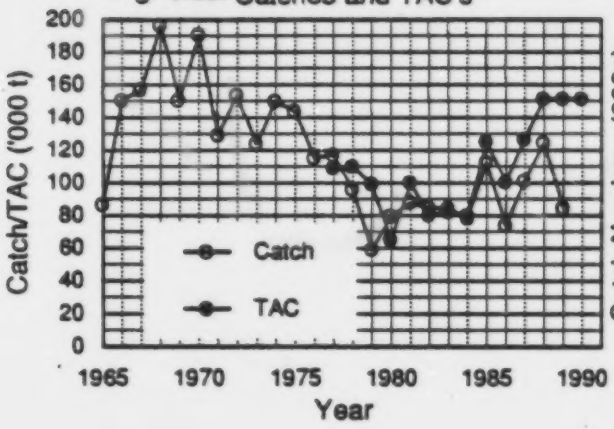



Fig. 3.2b. 1989 Catch-at-age

Fig. 3.2c. Abundance Indices

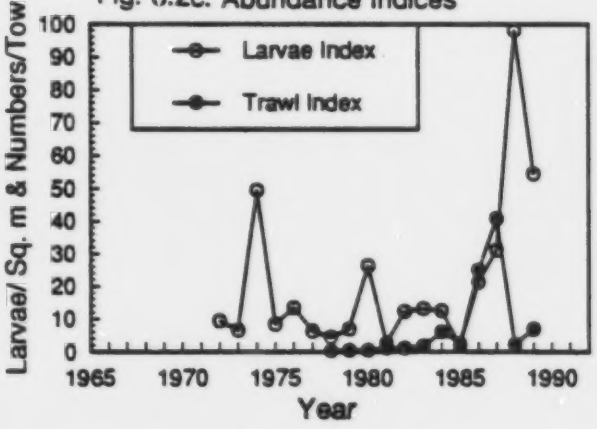
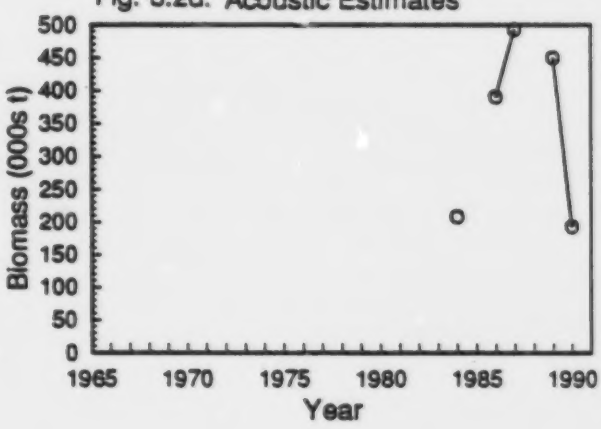



Fig. 3.2d. Acoustic Estimates



Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Advisory Document 90/5

## Advice on the Management of Groundfish Stocks

CAFSAC provides assessments for the groundfish stocks in NAFO Subareas 2-5 identified in Table 1 while the Northwest Atlantic Fisheries Organization (NAFO) reviews the assessments for the remaining groundfish stocks, that is stocks in Subarea 0+1, those stocks overlapping the 200 mile limit in Subarea 3, and silver hake in divisions 4VWX.

In 1990, CAFSAC presented the draft results of groundfish assessments at two Atlantic Groundfish Advisory Committee (AGAC) meetings. The intention was to consult with the trade prior to finalizing the advice. Several meetings were subsequently held with industry to discuss the 2J3KL cod and other stock assessments.

In this advisory document, CAFSAC provides catch options at various fishing mortalities in the context of a proposed three-year groundfish management plan. In that framework, CAFSAC's first priority is the conservation and protection of the resource. In addition to a forecast at $F_{0.1}$, if current stock size is estimated to be high enough not to be of concern, the 50% rule option or other options are presented. Current data and methodologies do not allow catch forecasts to be made for three years in advance with a high degree of certainty. CAFSAC believes that the actual catches will either differ from those forecast or result in different fishing mortality being applied to the stock. CAFSAC will therefore closely monitor the fisheries and, should indicators suggest a change in TAC in either direction, advice to that effect will be promptly provided.

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## 1. COD IN DIVISIONS 2GH

### 1.1. Description of the fishery

The nominal catches for this stock since the early 1950s have ranged from 94,000 t in 1966 to 131 t in 1987 and have been less than 500 t since 1985. The highest exploitation of this stock occurred in the late 1960s and early 1970s.

Recent TACs and catches ('000 t) are as follows (Fig.1.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Nominal catch | 1.5 | 0.5 | 0.5 | 0.1 | 0.4 | 0.4 | |

[1]Catches are preliminary

### 1.2. Abundance Indices

Analytical assessments using sequential population analyses (SPA) have not been possible for this stock in recent years because indices of abundance have not been available as a result of low catches and limited sampling data. Data from research vessel surveys using a stratified-random design were available annually from 1986 to 1988 only and these were not used as indicators of cod stock abundance. Their spatial coverage was limited and the seasonal timing was not optimal because research vessels were committed to other research programs at the appropriate time.

### 1.3. Assessment and Forecast

Data available in recent years have been insufficient to permit an analytical assessment of this stock and consequently advice relative to the $F_{0.1}$ level cannot be provided. In 1989 CAFSAC concluded that the relevance of the previously estimated $F_{0.1}$ catch (approximately 20,000 t) could not be determined. CAFSAC suggested that future catches be regulated but a quantitative recommendation could not be provided.

The present situation is essentially unchanged and there is again no current data or analyses to support a catch of 20,000 t. Directed fishing effort has been low in recent years because other fisheries have been more economical and accessible. Catches are expected to increase in the near future because of allocations to foreign fleets and increased interest by domestic fleets resulting from reductions in TACs for other cod stocks. Despite the lack of data and analyses, CAFSAC believes that the existing TAC of 20,000 t could be extended for 1991 to 1993.

## 2. COD IN DIVISIONS 2J, 3K AND 3L

### 2.1. Description of the Fishery

Total catches from this cod stock increased fairly rapidly after 1959 as the prespawning and spawning concentrations of cod off southern Labrador and northern Newfoundland were increasingly exploited by European fleets. The total catches peaked at about 800,000 t in 1968 but declined steadily thereafter until 1978. Inshore catches decreased from about 160,000 t in 1959 to 35,000 t in 1974.

Management of this stock, as for other stocks in the area, was initially the responsibility of the International Commission for Northwest Atlantic Fisheries (ICNAF). Early management measures were limited to minimum mesh size regulations, but the stock continued to decline and total allowable catch (TAC) regulations were introduced in 1973. The TACs at the time were set with the purpose of harvesting the maximum sustainable yield and maintaining the stock biomass, but the stock nevertheless continued to decline. Following extension of jurisdiction by Canada in 1977, the fisheries were regulated at a target fishing mortality lower than the target used previously, even below $F_{0.1}$, to allow the stock to rebuild. Since 1984, the fisheries have been regulated at a target fishing mortality of $F_{0.1}$. The stock was assessed by the Northwest Atlantic Fisheries Organization (NAFO) until 1986 and by CAFSAC since 1987.

Total catches increased slowly after 1978, and during 1982-1987 they were relatively stable around 230,000 t except in 1986 when Spain and Portugal took most of the foreign catch of 61,000 t on the nose of the Grand Bank outside of the 200 miles zone. This resulted in a total catch of 252,000 t for that year. Total catches reached 266,000 t in 1988 and decreased to 240,000 t in 1989 mostly because of decreased catches by the Canadian offshore sector. The 1989 TAC of 235,000 t was exceeded by about 5,000t because of foreign overfishing on the nose of the Grand Bank despite the NAFO moratorium.

Inshore catches increased steadily between 1974 and 1982 when they reached 113,000t. They declined afterwards to 72,000 t in 1986 and have recovered since to about 100,000 t. Compared to 1988, fixed gear catches have declined in northeastern Newfoundland (Division 3K) in 1989 but they have generally increased or remained stable in divisions 2J and 3L. For the total stock area, inshore catches in 1989 were about 100,000 t, which is almost 10,000 t above the average catches since 1977 and almost 6000 t above the longer-term average since 1959. There are indications that inshore fishing effort may have increased in 1989 as a result of fixed gear vessels based in NAFO Division 4S fishing in Division 2J out of Black Tickle in Labrador.

Recent catches and TACs ('000 t) are as follows (Fig. 2.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990[2] |
|---|---|---|---|---|---|---|---|
| Inshore Catch | 97 | 80 | 72 | 79 | 102 | 99 | |
| Offshore Catch | 135 | 151 | 179 | 156 | 164 | 141 | |
| Total Catch | 232 | 231 | 252 | 235 | 266 | 240 | |
| TAC | 266 | 266 | 266 | 256 | 266 | 235 | 197 |

[1]Catches are preliminary
[2]Canadian allocation

The labour dispute at Fishery Products International during 1989 disrupted the monthly distribution of catches. As a result, catches in the autumn of 1989 were proportionately more important than in previous years.

Information on the age structure of the catch is available since 1962. However, sampling of the catch was limited in the sixties and the early seventies, especially for the large foreign catches. The accuracy of the estimated age composition for those years is therefore considered low. Keeping those caveats in mind, CAFSAC notes that in those earlier years, a larger proportion, up to 20%, of the number of fish caught were age 8 or older while in recent years, these ages have generally accounted for less than 10% of the number of fish caught. This difference may be the result of poor sampling of the catch in the earlier period, of a lower abundance of larger, older cod in recent years, or of a refocussing of the fishery towards younger ages. The age composition of the 1989 fishery was unusual compared with other recent years in that ages 7 and 8 (the 1981 and 1982 year-classes) dominated in the catch, accounting for about

44% of the catch numbers. Since 1978, ages 5 and 6 usually made a much more important contribution to the total catch but the 1983 and 1984 year-classes (ages 6 and 5 in 1989) which would have normally been expected to dominate the 1989 catches, appear to be small, even smaller than estimated in last year's assessment.

## 2.2. Abundance Indices

The results of research vessel surveys conducted in the autumn since 1978 and data from the commercial fleet in tons per hour for the same time period have recently been used as indices of abundance for this cod assessment. Offshore foreign mobile gear catch per unit of effort is available for a longer period prior to 1978 but there is little information for those fleets after 1978. As indicated in last year's assessment, because there is very little overlap in the periods of activity of the Canadian fleet and the foreign fleets, it is not possible to reliably combine the two series into a single series covering the entire period from 1960 to 1989.

The fishing practices on the research vessel have largely remained the same over the period. The total area surveyed has been divided into various zones (stratum) based on the depth of each zone because the distribution of cod is generally related to water depth. A given number of fishing sets is allocated to each of these zones according to its size. The locations of the fishing sets are selected at random each year to ensure an unbiased coverage of the area of distribution. In divisions 2J and 3K, the surveys have always been conducted on the research vessel Gadus Atlantica while three vessels have been used for the Division 3L surveys. Appropriate adjustment factors have been applied between the three vessels in order to make the results comparable from year to year. Population indices in weight from the research vessel surveys are shown in Fig. 2.2. The results suggest that the stock has been relatively stable since 1987. There are clear indications that the cod were more available to the research trawl in 1986 and CAFSAC considers that the biomass estimate for that year is artificially high. The reasons for the increased availability are unknown but CAFSAC notes that it was a widespread phenomenon affecting other species in this area.

By contrast to the fishing practices on the research vessel surveys which have remained similar over the period 1978-1989, those of the commercial fleet have changed considerably over these years. Although an offshore Canadian cod fishery has existed for a long time in Division 3L, there were only occasional catches in divisions 2J and 3K prior to about 1978. The Canadian fishers must therefore have experienced a certain degree of learning about the location of the fish and vessel operation in these waters at least for the first two or three years, that is until about 1980-81. In addition, several other factors, of which a non-exhaustive list is given below, have all undoubtedly had an effect on catch per unit of effort of the commercial fleet albeit sometimes in opposite directions:

- the introduction of enterprise allocations in 1983;
- an increase in mesh size in the early 1980s;
- the emphasis placed on fish quality instead of fish quantity in the early to mid-1980s which resulted in the cutting of holes in trawls in an attempt to limit the catch to a desired level;
- the introduction of better navigation and fish detection equipment;
- the introduction of trawl mensuration equipment; and

- the regulation to harvest 1/3 of the allocation in each of the three divisions since 1987.

CAFSAC has attempted to quantify the effect of these factors in last year's assessment. The main factors investigated were the impact of the 1/3,1/3,1/3 regulation, the cutting of holes in the trawl and the by-catch nature of the Division 3L cod fishery. None were found to have had a significant effect and therefore CAFSAC is making no adjustment to the data in calculating the index of the success of the fishing fleet. CAFSAC considers however that the many changes in the commercial fishery, especially the learning that is bound to have happened in the first years after 1978, invalidate the use of the commercial catch per unit of effort as a consistent index of stock size over the entire time period considered. The commercial catch per unit of effort is shown in Fig. 2.3 and CAFSAC believes that the rapid increase in catch per unit of effort from 1978 to 1982 is the result only of increases in stock size but also of a learning process which allowed Canadian fishers to become more efficient harvesters of this resource. The commercial catch per unit of effort is relatively stable between 1988 and 1989.

## 2.3. Assessment

The present assessment uses the research vessel survey results in a way very similar to what was done in the 1989 assessment. For the commercial fleet however, and as suggested in the report of the Harris Panel on northern cod, estimates of the success of fishing in number of fish per hour have been calculated for each age. In last year's assessment an index which was aggregated over all ages in tons per hour had been used.

By examining the success of the commercial mobile gear fishery on an age by age basis, CAFSAC has been able to identify that the mobile gear catch per unit of effort at age for ages 5 to 8 could be used as an abundance index.

The ADAPT methodology was used to assess stock size. This methodology, which may appear complicated at first, provides a rigorous framework which allowed the investigation of a biological phenomenon which had remained somewhat elusive until now. This is the relative fishing mortality pattern over ages (the partial recruitment vector) which, in past assessment had been estimated to increase from ages 3 to about age 7 and remain constant for the older ages. It had long been observed, by comparing the age composition of research vessel surveys with that of the fishery, that there appeared to be more older fish in the surveys than in the commercial fishery. In fact, in a fishery like the 2J3KL cod fishery where traps and otter trawls catch mostly fish younger than age 8 or 9, it would be expected that the older ages (age 10+) are subjected to a lower exploitation rate than the middle ages (age 7 to 9) which constitute the prime target for the majority of the fishery. The examination of the preliminary ADAPT runs suggested that fish ages 10 and older were not as highly exploited as those from ages 7 to 9. The relative exploitation rate appears to be maximum at ages 7 to 9 and to decrease progressively on older ages to be about 50% on age 13.

The ADAPT methodology also helped substantiate a suspected increase in efficiency for the mobile gear fleet between 1977 and 1982. This increase in efficiency was misleading in past assessments and suggested that the stock size had increased more rapidly than it actually had. To be able to use the commercial catch per unit of effort for those earlier years would require adjusting them to take into account the increase in efficiency. Although the indications are clear that efficiency has increased during the period, CAFSAC has no basis to decide what the yearly adjustments should be. For this reason the years (1978-1982) were excluded from the analyses until a correction for the increases in efficiency can be made. CAFSAC is aware that other changes in efficiency have occurred since 1982 but these were not all in the same direction with some increasing efficiency

while others may have decreased it. In addition, as indicated in the report "Independent Review of the State of the Northern Cod Stock", it is preferable to use several indices of stock size when doing an assessment and therefore, CAFSAC elected to retain the commercial index of stock size for 1983 to 1989 despite its recognized weaknesses.

The final assessment of population size was calibrated age by age using the research vessel indices for ages 3 to 12 for 1978 to 1989 and the commercial catch per unit of effort at age for ages 5 to 8 for 1983 to 1989. The results confirm the information provided in the 1989 assessment that the exploitation rate had been underestimated in previous assessments, including the 1989 assessment. The Review Panel on Northern Cod hinted at this result in their report when they indicated that if the fishing mortality in 1988 was not F=0.45 as estimated by CAFSAC in the 1989 assessment, it was probably higher. The results of last year's assessment indicated that the biomass had reached a peak in 1984 and had remained relatively stable around one million tons since. The current assessment (Fig. 2.4) shows the same maximum biomass in 1984 but a slight decline since with the 1989 biomass being close to 800,000t.

In last year's assessment the 1983 and 1984 year-classes were estimated to be slightly lower than average. In the current assessment (Fig. 2.5), these year-classes are estimated to be about the size of the smallest year-classes observed since that of 1959. The 1986 year-class is presently estimated to be about 1.5 times stronger than the average year-class size since 1977, that is about 475 million fish.

The fishing mortality (Fig. 2.6) for ages 7 and older is estimated to have increased steadily since 1978 and to be currently similar to early 1970s, which is slightly higher than the average of about 0.50 since 1962. The fishing mortality appears to have approximately doubled during the course of the 1980s.

The reasons for the difference in the two assessments, in spite of the relative stability in the two indices used, is because more weight has been given to the research vessel survey results in the current assessment. In last year's assessment, CAFSAC was uncertain as to the appropriate way to combine the research vessel surveys population indices by age and the commercial catch per unit of effort by year for 1978 to 1988 within a single assessment of stock status without artificially giving much more weight to the research vessel surveys because of the higher number of observations. Therefore, each index was used separately thus providing two independent assessments. The research vessel index suggested a fishing mortality in 1988 about twice as high as that indicated by the commercial data for the same year. CAFSAC took the mid-distance between these two values as being consistent with the recent estimates of exploitation observed in the fishery. This was done even though the relationships with the research vessel surveys were much better than those for the commercial catch per unit of effort.

Consistent with the recommendations given in the "Independent Review of the State of the Northern Cod Stock", the present assessment used population estimates on an age by age basis not only for the research surveys but also for the commercial catch per unit of effort indices. This allowed the two indices to be combined into a single assessment and each to be weighted according to its relationship with the estimates of stock size from sequential population analyses. The statistical model used to find the best compromise between the two indices recognized the weaknesses of the commercial catch per unit of effort relationships and gave a predominant weight to the research vessel indices. In last year's assessment, the calibration of the SPA with the commercial catch per unit of effort on its own resulted in stock size estimates twice as high as those obtained by calibrating the SPA only with the research vessel surveys population indices. As anticipated in the report of the Harris Panel, the results of the calibration of the SPA using the commercial catch per unit of effort (CPUE) on

its own but on an age by age basis gives population estimates that are still larger than those obtained by calibration with the research vessel survey results alone but the difference has been cut by about half (Fig. 2.7). CAFSAC estimated the effect of not using the first 5 years of the Canadian offshore CPUE in the calibration and found that it decreased the estimates of the ages 5 to 8 populations by about 4%.

## 2.4. Forecast

The 2J3KL spawning biomass is estimated to be presently more than twice the lowest value observed in the mid-1970s and about equal to the spawning biomasses that produced the relatively strong 1979 to 1982 year-classes. The 1986 year-class is estimated to be strong and it will likely cause a large increase in the spawning stock biomass when it matures in 1993. In the meantime, the 1983 and 1984 year-classes are so small that the spawning biomass will decline in 1990 and 1991 even if it were decided to decrease the fishing mortality to $F_{0.1}$ immediately in 1991. However, considering the likely impact of the 1986 year-class on the spawning biomass in 1993 and thereafter, CAFSAC believes that considerations of spawning stock biomass do not require that the fishing mortality on 2J3KL cod be reduced immediately to $F_{0.1}$ in 1991.

CAFSAC is therefore providing, in the table below a range of alternative exploitation options considered biologically acceptable for 1991. In all cases, the 1990 catch is assumed to be about 225,000 t because CAFSAC recognizes that fishing on the nose of the Grand Bank is likely to occur despite NAFO's moratorium. Total catches in 1990 are therefore expected to exceed those allowed in the 1990 Groundfish Management Plan.

The following input values were used in the catch projections:

| AGE | January 1990 Population numbers ('000s) | Weight (kg) | Partial Recruitment |
|---|---|---|---|
| 3 | 300000 | .47 | .006 |
| 4 | 387485 | .71 | .152 |
| 5 | 154490 | 1.05 | .474 |
| 6 | 53593 | 1.38 | .608 |
| 7 | 40015 | 1.79 | 1.000 |
| 8 | 46866 | 2.07 | 1.000 |
| 9 | 27481 | 2.65 | 1.000 |
| 10 | 8176 | 3.19 | .802 |
| 11 | 4259 | 4.38 | .798 |
| 12 | 2477 | 5.18 | .878 |
| 13 | 692 | 6.60 | .500 |
| 14 | 645 | 7.99 | .500 |
| 15 | | 9.45 | .500 |

| Option | Fishing Mortality[1] | 1991 Catch | 1991 Net Production[2] | 1991 Spawning Biomass |
|---|---|---|---|---|
| $F_{0.1}$ | F=0.20 | 100,000 t | 115,000 t | 230,000 t |
| 50%Rule | F=0.33 | 150,000 t | 65,000 t | 185,000 t |
| $2XF_{0.1}$ | F=0.40 | 170,000 t | 45,000 t | 170,000 t |
| Surplus production | | 215,000 t | 0 | 130,000 t |

[1]Ages 7 and older
[2]Represent the increase in biomass between January 1, 1991 and January 1, 1992.

The surplus production is estimated at about 215,000 t for both 1990 and 1991. Therefore, if the catches did not exceed those allowed in the 1990 Groundfish Management Plan, the stock would grow slightly and up to about 215,000 t could be harvested in 1991 while keeping the biomass stable.

These options are largely dependent on the size of the 1986 year-class. CAFSAC is confident that the 1986 year-class is strong, but its actual strength will be estimated with greater accuracy when the year-class has contributed to the fishery for a few more years.

## 3. COD IN SUBDIVISION 3Pn AND DIVISIONS 4RS

### 3.1 Description of the Fishery

Landings for this stock reached a peak of 106,000 t in 1983 but have decreased since to 47,000 t in 1989, the lowest observed since 1960. The mobile gear catches from Canadian vessels were stable from 1981 to 1986, decreasing slightly thereafter. This decline can be attributed in part to a strike in the winter of 1988 and to the exclusion of Metropolitan France from the fishery in 1987. Fixed gear catches have declined drastically since 1982. The proportion of the total catch taken by the mobile fleet in 1989 is 70%.

Preliminary values for landings to date in 1990 are lower than those of the similar period in 1989. Severe ice cover hampered the winter fishery in Subdivision 3Pn with vessels being tied up for three weeks. Total catches in 1990 are expected to be lower than 40,000 t. TACs and nominal catches ('000 t) are as follows (Fig. 3.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 100 | 100 | 92.1 | 80.3 | 73.9 | 76.5 | 58 |
| Nominal catches | 104 | 88 | 80 | 67 | 48 | 47 | - |

[1]Catches are preliminary

### 3.2. Abundance Indices

*Commercial catch rates (Fig. 3.2)*

Catch rates from otter trawl tonnage class 2 to 5 vessels were analyzed using a multiplicative model. The proportion of the total catch for which effort is available is in the range of 15 to 30% in recent years. Catch rates were

stable from 1974 to 1980, increased twofold between 1980 and 1981 with a slight decline since then.

*Research vessel survey data (Fig. 3.3)*

Two annual groundfish surveys are conducted in the northern Gulf of St. Lawrence, one in August-September aboard the RV Lady Hammond since 1984 and another in January aboard the RV Gadus Atlantica since 1978 (except 1982). The summer survey was thought to underestimate biomass since few sets were done in the 50-100 fathom strata in the first three years. Estimates for these strata were derived using a multiple regression with year and stratum effects. The resulting biomass estimates show a gradual decline since 1984, with the 1988 and 1989 observations being the lowest in the time series. The summer survey is presently of limited use for calibration mostly because it is a short series and because waters 50 fathoms or less are not surveyed because of the presence of fixed gear. Keeping in mind these drawbacks, the trend in biomass estimates from the summer survey indicate a decline of biomass for this stock.

Estimates from the winter survey remained relatively stable between 1978 and 1983, increased by a factor of two between 1984 and 1986 and have suddenly declined in 1987. The four most recent biomass estimates are the lowest in the time series. The biomass estimates from this survey are quite variable compared to other surveys because the cod are concentrated in a small part of the survey area, resulting in large within-year variability. Past reservations about ice cover and migrations into 3Ps have been investigated. CAFSAC believes these are unlikely to be important because several sets are made each year in areas covered by ice and they yield small catches, indicating that few cod are present in the icebound unsurveyed area. Results from tagging studies suggest that there are little incursions of 3Pn 4RS cod into Subdivision 3Ps.

Population estimates for the 1986 and 1987 year-classes are the largest in both research vessels population estimates. They were first detected at age 2 in the 1988 and 1989 winter surveys respectively. The 1987 year-class estimate from the 1990 survey is second to the largest observed value. These observations are corroborated by anecdotal information from the commercial fishery in 1990 that many small fish were caught.

*Stock structure*

A tagging program was undertaken jointly by the Department of Fisheries and Oceans and the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec in order to evaluate claims by industry that important incursions of cod from divisions 2J, 3K, and 3L were occurring in the northern Gulf of St. Lawrence. To test this hypothesis, fish were tagged in the summer months when stocks are presumed to be mixed. Returns from the January to March period were considered to be taken from discrete stocks when they are segregated prior to spawning.

Approximately 50,000 fish were tagged during the summers of 1983 to 1986. Fish were tagged from inshore traps and from the RV Lady Hammond offshore. Tagging sites covered most of the summer distribution of the stock and were located on the west coast of Newfoundland from the Strait of Belle Isle to the Port au Port Peninsula and on the Québec north shore from the Quebec - Labrador border to the west end of Anticosti Island.

Returns of approximately 6,000 tags indicate that: 1) cod tagged at the northern tip of western Newfoundland (Quirpon-Cooks Harbour area) were recaptured predominantly in divisions 2J3KL; 2) cod tagged on the remainder of the west coast of Newfoundland were recaptured predominantly in divisions 3Pn4R with few returns from divisions 2J3KL; 3) cod tagged on the Quebec North Shore were almost

exclusively recaptured in divisions 3Pn4R; and 4) while most cod tagged at the western tip of Anticosti Island were recaptured in divisions 3Pn4R, substantial numbers were recaptured from divisions 4T, 4Vn and 4Vs. Very few cod were recaptured from Division 3Ps and those that were came from the Burgeo Bank area. The results however somewhat overestimate the contribution of 2J3KL cod to northern Esquiman Channel cod catches because a greater proportion of the total returns within the Gulf were deleted from the analysis since they were returned with incomplete information.

CAFSAC concluded that no major incursions of 2J3KL cod had taken place between 1983 and 1986 and although exchanges exist with 2J3KL in the Strait of Belle Isle, the 3Pn 4RS cod stock appears to be relatively discrete. Further, CAFSAC noted that the few returns from Division 3Ps indicate that fish tagged in the summer make limited incursions into Subdivision 3Ps.

### 3.3. Assessment and Forecast

The two indices of abundance when used separately to calibrate SPA, imply in very different interpretations of the abundance of this cod stock. The calibration with the trawler CPUE suggests that the stock is relatively stable and lightly exploited. The calibration with the winter survey suggests that the stock is exploited above $F_{max}$ and declining at a rapid rate. Because of the divergent trends in the abundance indices and the shortcomings of each index, CAFSAC is unable to precisely assess the size of the 3Pn 4RS cod, although a decline in abundance is evident.

Past assessments were based entirely on commercial catch per unit of effort indices of the mobile gear fleets. However, in recent years, trends in CPUE are conflicting with all other indications from the fishery; catches from the fixed gear fishery have virtually collapsed and both surveys show an important decline in biomass. This led CAFSAC to believe more the results from the surveys which show a substantially more pessimistic view of the resource. It is difficult however, to reconcile the recent dynamics of the 3Pn 4RS cod stock with its previous history. The stock has generally produced catches in excess of 60,000 t with average catches being about 80,000 t. CAFSAC is concerned that rumoured misreporting and discarding may play a role in this apparent drastic change in productivity. Considering the past and recent dynamics of this stock, CAFSAC believes that mobile gear catches should not be allowed to increase over those of 1990 and that discards and dumping should be halted.

## 4. COD IN DIVISION 4T AND IN SUBDIVISION 4Vn (JANUARY-APRIL)

### 4.1. Description of the Fishery

Since 1950, nominal catches have ranged from a high of over 104,000 t in 1956 to a low of 22,000 t in 1977. Between 1980 and 1986, nominal catches have averaged approximately 60,000 t. Catches have varied between 50,000 and 52,000 t in the past three years. The nominal catch in 1989 was approximately 4,000 t less than the TAC. Part of the shortfall can be attributed to transfers from fixed gear to mobile gear which were made using a 2:1 ratio. TACs and nominal catches ('000 t) in recent years are presented below (Fig. 4.1.):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 67 | 67 | 60 | 45.2 | 54 | 54 | 53 |
| Nominal catch | 55 | 62 | 64 | 51 | 52 | 50 | - |

[1]Catches are preliminary

Landings in the winter fishery in 4Vn accounted for approximately 18% of the total catch and are attributed almost exclusively to otter trawlers. France caught 503 t from an allocation of 1,360 t. Landings by fixed gear were the lowest on record since 1965 at 6,655 t. Catches by mobile gear (seiners and otter trawlers) were similar to 1988. Proportions taken by the Maritimes (65%), Newfoundland (3%), and Quebec (31%) remained approximately the same as in 1988.

The system of enterprise allocations (EA) instituted in 1988 was extended to include all mobile gear vessels over 50 feet. Trip limits were imposed on mobile gear vessels less than 50 feet. Allocations were generally reached quickly for mobile gear vessels less than 45 feet.

Most gear and quarter components were adequately sampled for age with a total of nearly 81,000 fish measured and 6,700 aged. The results of age determination comparisons indicated that the level of agreement in age determinations between readers and a reference collection exceeded 70%. There was no evidence of bias with respect to the difference between readers.

The 1982 and 1983 year-classes accounted for 20.6% and 23.3% respectively of the numbers caught in 1989. The 1980 year-class has appeared in large numbers in the catch since 1985 and comprised 14.1% of the catch in 1989. The proportions observed in the fishery were in close agreement to those predicted in the previous assessment.

Weights at age for 1989 were generally higher than in 1988 at the younger ages (3-5), however the average weights of older fish (age 9+) are the lowest observed in the time series. The decrease in fixed gear catches in 1989 may have contributed to the decrease in average weight at age in the catch because weights at age for older fish are generally lower for mobile gear catches and higher in fixed gear catches.

## 4.2. Abundance Indices

Catch rates for otter trawlers were calculated using a multiplicative model. Catch rates decreased from 1968-75 followed by a general increase to 1987 with a subsequent decline. Current catch rates are approximately twice those observed in the mid-1970s (Fig. 4.2).

Analysis of catch rates for the fixed gear (gillnets, longlines and handlines) using purchase slips was attempted using a multiplicative model. The number of days fished appears to have decreased by 50% since 1987 but the measure of effort used (days fished) appears too crude to allow the use of fixed gear CPUE as an index of stock size. No significant yearly trends in CPUE could be detected.

### *Discarding Practices*

Estimates of discards of cod in Division 4T from the Quebec observer program indicated a discard rate by weight of 9.2%; this is lower than the 1988 estimate of 14.6%, which is comparable to discard rates previously observed in this fishery. An analysis of data collected by the International Observer Program (IOP) of the Scotia-Fundy Region from 1985 to 1989 indicated that discard rates have increased from less than 1% in 1986 to 5% in 1989 in 4Vn (Jan.-Apr). Discards appear to be highest in the area of Scatarie Bank. Estimates of discards are available only for a few years and they have not been incorporated into the assessment.

*Research vessel survey data (Fig. 4.3)*

Comparisons of the results of day/night tows failed to detect a significant difference between day and night catches of cod in 4T. Consequently, day and night sets were used in 1989. This increased the number of sets used in the calculation of the abundance index to 164 in 1989 from 60 to 70 in previous years. Mean numbers per tow at age 3+ estimated from the 1989 survey are approximately 40% lower than in 1988 but at a level comparable to 1987. Coefficients of variation ranged from 11 to 14% for the most abundant age classes (4 to 12). The 1979 and 1980 year-classes are still present in large numbers in the population. As in the previous assessment, the 1982 year-class appears to be above average but the 1984 year-class does not appear as large as in previous surveys. The 1987 and 1988 year-classes appear to be above average. These juveniles were found in several sets in the lower Shediac Valley - Miramichi Bay area and the northern and eastern coasts of P.E.I.

## 4.3. Assessment

The sequential population analysis was calibrated by combining the two abundance indices in a single ADAPT run.

*Recruitment (Fig. 4.4)*

Based on the calibration, the estimate of the 1986 year-class was 140 million fish. However, the estimate was not considered precise and the size of this year-class was set equal to the geometric mean of the 1968- 1984 year-classes at 104 million. The 1984 year-class, which was estimated to be the second largest in the time series in the last assessment, is now estimated to be somewhat smaller at 127 million. The 1979-1982 year-classes are all estimated to be above the mean and the 1979 and 1980 values are the largest in the period 1947-1985.

*Fishing mortality and stock abundance (Figs. 4.5 and 4.6)*

The 3+ average population biomass declined from a high of 500,000 t in 1955 to approximately 100,000 t in the mid-seventies. With the reduction of fishing mortalities in 1977-78 and the recruitment of the 1974 and 1975 year-classes, the biomass increased and appears to have been stable at approximately 400,000 t since 1982. Population numbers in the 1980s are at their highest level since 1950. Although recent biomass estimates are similar to those in the early 1950s, the total population numbers since 1980 are substantially higher (Fig. 4.7) because the average weights at age is now smaller.

## 4.4. Forecast

Catch projections to 1993 were made using the 1990 beginning of the year population numbers. Weights at age were the average from 1987-89. The exploitation pattern over ages was derived from fishing mortalities in the period 1985-88 assuming full recruitment at age 9. Age 3 recruitment for the 1988-1989 year-classes was set at the geometric mean of the 1968-84 year-classes of 104

million. Input data are given below:

| Age | January 1990 Population numbers (000) | Average Weight (kg) | Partial recruitment |
|---|---|---|---|
| 3 | 104,000 | 0.389 | 0.005 |
| 4 | 85,097 | 0.564 | 0.078 |
| 5 | 104,203 | 0.745 | 0.269 |
| 6 | 63,917 | 0.893 | 0.662 |
| 7 | 44,893 | 1.039 | 0.775 |
| 8 | 33,603 | 1.203 | 0.862 |
| 9 | 19,898 | 1.441 | 1.000 |
| 10 | 25,571 | 1.869 | 1.000 |
| 11 | 11,569 | 2.210 | 1.000 |
| 12 | 3,835 | 2.863 | 1.000 |
| 13 | 2,058 | 3.375 | 1.000 |
| 14 | 696 | 4.374 | 1.000 |
| 15 | 225 | 7.997 | 1.000 |

The 1990 TAC of 53,000 t implies a fully recruited fishing mortality of 0.253. An $F_{0.1}$ catch in 1990 would result in landings of 43,000 t. In the context of multi-year advice, CAFSAC considered 3 options for 1991, 1992 and 1993. The options are presented below with the implied fishing mortality and catch.

| | F(8+) | | | | | Catch('000 t) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| OPTION | 1989 | 1990 | 1991 | 1992 | 1993 | 1989 | 1990 | 1991 | 1992 | 1993 |
| 1) 53,000 t in 1990; 50% rule in 1991; $F_{0.1}$ in 1992 and 1993 | 0.24 | 0.25 | 0.23 | 0.20 | 0.20 | 50 | 53 | 48 | 43 | 43 |
| 2) 53,000 t in 1990; 50% rule in 1991 in 1992 and 1993 | 0.24 | 0.25 | 0.23 | 0.21 | 0.20 | 50 | 53 | 48 | 46 | 43 |
| 3) 53,000 t in 1990; 1991-1993 | 0.24 | 0.25 | 0.25 | 0.26 | 0.27 | 50 | 53 | 53 | 53 | 53 |

CAFSAC noted that all options would result in a slight decrease in the 3+ biomass over the 1989 level. However, the estimate of recruitment of 104 million is small compared to year-class sizes observed since 1977 and the stock biomass is currently high. Therefore, CAFSAC concludes that a catch of 53,000 for 1991 to 1993 would result in a reasonable level of exploitation for this stock. However, as mentioned in the introduction, CAFSAC believes that the actual catches will either differ from those forecast or result in different fishing mortality being applied to the stock. CAFSAC will therefore closely monitor the fisheries and, should indicators suggest a change in TAC in either direction, advice to that effect will be promptly provided.

## 5. COD IN SUBDIVISION 4Vn (MAY-DECEMBER)

### 5.1. Description of the Fishery

The nominal catch for 1989 was 69 t over the 7,500 t TAC. Although there were overruns of allocations for the mobile and fixed gear < 45' early in the fishing year, shortfalls for most of the other allocation categories and a decision early in the season to manage allocations as a condition of the license resulted in a final catch essentially equal to the TAC.

There were reports from the fishermen of abundant early runs of "small" fish in the late autumn of 1989. The appearance of this run is usually taken to indicate the onset of the migration of 4T cod into Sydney Bight for the winter.

TACs and nominal catches ('000 t) are as follows (Fig. 5.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 14.0 | 12.0 | 12.0 | 9.0 | 7.5 | 7.5 | 7.5 |
| Nominal catch | 10.4 | 12.5 | 11.8 | 10.2 | 9.0 | 7.6 | - |

[1]Catches are preliminary

The 1981 to 1984 year-classes were almost equally represented (15-22%) in the longline catches, accounting for 77% of the numbers caught. The contribution of these year-classes to the otter trawl catches is exactly the same total percentage as for the longline catches but the contribution increases progressively from 9% for the 1981, 16% for the 1982, 22% for the 1983 and 30% for the 1984 year-classes. Patterns in the catch at age in 1989 were similar to those in previous years with the otter trawls concentrating on younger ages than the longlines. Decreases in average weights for ages 5-11 in 1989 over those observed for the same ages in 1988 were large. The average weight in the catch for all ages decreased from 1.97 kg in 1988 to 1.49 kg in 1989 with very little change in average age. The corresponding decrease in average length in the catch was from 65.3 cm to 60.7 cm. Fish of ages 8-11 in 1989 had the smallest average length at age for the period 1982-89. This decrease may be related to an influx of Division 4T cod.

*Commercial catch rates*

The catch rate series for longliners of tonnage class 2 and 3, and otter trawlers were analyzed in the last assessment of this stock and CAFSAC concluded that neither could be used as an index of abundance.

*Research vessel survey data*

The 1989 survey estimates of mean numbers and mean weight per tow indicated a small increase in overall abundance from 1988 (Fig. 5.2). The 1989 estimate mainly reflected the influence of two sets where large numbers of cod were caught. The annual estimates of abundance from this survey are quite variable but CAFSAC concluded that the overall lack of trend could be interpreted as relative stability since 1981. The 1981, 1982 and 1984 year-classes were the most abundant in the survey catches.

## 5.2. Assessment

The observation of significant decreases in size at age in 1989 from that observed in 1988 and the anecdotal information concerning the earlier appearance of the run of "small" fish suggests that cod from the 4T stock were in 4Vn earlier and possibly, in greater numbers than usual. CAFSAC concludes that the variability in the degree of mixing between the resident 4Vn cod stock and adjacent stocks makes it impossible to calibrate a virtual population analysis based assessment. The events of 1989 relating to the earlier incursion of the 4T stock into 4Vn make previous estimates of fishing mortality for this stock suspect if such events have occurred in the past.

## 5.3. Forecast

The information available on this stock indicates that on the average, catches of 10,000 t have been taken in 4Vn (May - December) since 1982 without any concurrent sustained decreases in the research survey index. The recent survey estimates (1982-89) are at a higher level than over the previous period of 1970-1981 when average catches were 8,000 t. Although, the fishing mortality has likely been above $F_{0.1}$ in recent years, the recent catches do not seem to be detrimental to the 4Vn resident cod stock given the survey results. In fact, if the interpretation of the research vessel surveys is correct, the stock has been relatively stable since 1982 with average catches of about 10,000 t. Catches between 7,500 t and 10,000 t are likely to be sustainable for at least the next three years.

# 6. COD IN SUBDIVISION 4Vs AND DIVISION 4W

## 6.1. Description of the Fishery

Catches of 4VsW cod ranged from 40,000 t to 80,000 t from 1958 to 1974 and then declined rapidly to a low of 10,000 t in 1977. With the extension of jurisdiction in 1977, the catches increased rapidly again and were at or above 50,000 t from 1980 to 1986. The TACs have been subsequently reduced and the catches have declined in recent years to 36,662 t in 1989. The TAC and nominal catches ('000 t) from 1984 to 1990 are (Fig. 6.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 55 | 55 | 48 | 44 | 38 | 35.2 | 35.2 |
| Nominal catch | 53 | 57 | 52 | 46 | 38 | 37 | --- |

[1]Catches are preliminary

For the sixth consecutive year, 80% or more of the catch was taken in 4Vs. The split between gear sectors was slightly different from 1988 and 1987 with 70% taken by otter trawlers (down 5%) and 23% by longliners (up 4%). The remaining 7% of the catch was taken by seines and gillnets. All vessels less than 100 ft were under trip limits and by-catch regulation all year. For the first half of the year, the fishery was regulated by means of variation orders as was done in previous years, however after May, regulation was done by means of Conditions of Licence. The change in means of regulation has made it difficult to track the regulations under which the inshore vessels were operating throughout the remainder of the year. The offshore vessels greater than 100 ft operated under enterprise allocations and as such did not have trip limits imposed by the Department of Fisheries and Oceans. However company imposed trip limits and

other measures were in place throughout the year and were closely managed by the company.

The 1980 year-class was still a significant contributor to the catch (15% by weight) and was the largest year-class at age 9 in the catch at age. The 1983 year-class was the smallest catch at age 6 since 1978 although it was higher than projected. The catch of the 1986 year-class at age 3 was the largest observed at that age since the change in minimum mesh size implemented in 1983.

The weights at age in the commercial catch continued to decline relative to the previous year at most ages; however the research survey mean weights at age were higher or stable for most ages.

## 6.2. Abundance Indices

*Commercial catch rates (Fig. 6.2)*

Standardization of the commercial catch per unit of effort for otter trawlers using a multiplicative model indicated that it has declined by a factor of almost three since 1986. However, this decline may have been influenced by factors such as company imposed trip limits. The otter trawler catch has been dominated by tonnage class 5 trawlers since 1977. Since the advent of enterprise allocations in 1984 these vessels have not operated in the context of a competitive fishery. Trip limits have been used by National Sea Products (NSP) since 1984 and the limits have become more stringent in the past few years as their enterprise allocations have been reduced. Reports have indicated that National Sea Product's skippers are more concerned with obtaining the desired combination of species' catches on a trip and are therefore not trying to maximize catch rates as they used to.

Because of the way the commercial statistics on catch and effort are compiled, there is a likelihood that commercial catch per unit of effort is being underestimated. The International Observer Program (IOP) has collected set-by-set catch and effort data since its inception, although coverage was not adequate prior to 1982. The data were carefully selected such that only cod-directed sets were included in the analysis. A multiplicative model was used to standardize the observer catch per unit of effort from the tonnage class 5 otter trawler fleet. The catch rate thus obtained was considerably higher and showed a different trend than the one derived from the commercial statistics. CAFSAC concludes the commercial catch per unit of effort is not a reliable index of the abundance for 4VsW cod over the period 1970 to 1989, because among other factors, of changes in the way the fishery is prosecuted. CAFSAC will investigate further the potential usefulness of observer data to calculate an index of abundance for 4VsW cod.

*Research vessel survey data (Fig. 6.3.)*

The July stratified random trawl survey of the Scotian Shelf has been conducted annually since 1970. The estimates of abundance for 1970 are not utilized for this stock because of variations in gear and survey protocol. In addition the estimates were deemed inconsistent with the sequential population analysis estimates for 1970. Because of differences in age composition, stratified estimates of catch per tow at age were calculated for 4Vs and 4W separately and combined by weighting by stock area for the years 1971 to 1989. The age 4+ abundance has declined in both 1988 and 1989 although the total abundance has been stable. A survey has been conducted in March in the years 1979-1989 with the exception of 1985. The abundance index from the March 1990

survey is the second lowest of the series with only the 1979 value being lower. The eastern portion of Subdiv. 4Vs could not be surveyed in March 1990 because of ice coverage, but in the surveyed areas, cod appeared concentrated in the Sable Island Gully. The 1986 and 1987 year-classes were the most abundant, representing 66% of the total. The July survey index increased marginally from 1986 to 1990. Similar to the March survey, the 1986 and 1987 year-classes were the most abundant. The 1987 year-class was the largest at age 3 since the 1980 year-class and the 1986 year-class appears of a strength comparable to the strong 1981 year-class at the same age.

## 6.3. Assessment

The sequential population analysis was calibrated with ADAPT using the two surveys as indices of abundance. In an attempt to better match SPA and the survey, catch at age was calculated on a semi-annual basis. The July index was compared to July 1 population numbers and the March index with March 1 estimated numbers.

### *Fishing mortality and stock abundance*

The stock abundance expressed in numbers or biomass (Fig. 6.4), increased from the mid-1970s to the mid-1980s, reflecting the decreased exploitation and recruitment of the strong 1978-80 year-classes. The subsequent decline in abundance resulted from the recruitment of the three poorest year-classes (1983-85) on record. The mean (ages 7-9) fully recruited fishing mortality (Fig. 6.5) was 0.38 in 1989, almost twice the $F_{0.1}$ level of 0.2, and has varied around the 1989 value since 1980. Recent fishing mortalities, however are well below those of the late 1960s and 1970s. The assessment shows the 1979 and 1980 year-classes as the strongest in the 1970 to 1990 period and the 1983 year-class as the smallest (Fig. 6.6). The 1984 and 1985 year-classes also appear small.

The estimated decline in abundance is corroborated by industry reports, particularly for the fixed gear, which indicate that cod have been scarce in 4VsW during the 1990 fishery. The 1990 fixed gear allocations will probably not be reached and there were a few reports of abundant small fish being discarded by the mobile fleet. These two observations are consistent with the present estimates of the weak 1983-85 year-classes which would be contributing to the fixed gear catches and the strong 1986 and 1987 year-classes which would start to recruit to the mobile gear fisheries.

## 6.4. Forecast

Catch projections for 1991 were made using the input data in the table below:

| Age | January 1990 Population numbers ('000) | Average Weight (kg) | Partial recruitment |
|---|---|---|---|
| 1 | 77,000 | .067 | .0001 |
| 2 | 63,042 | .279 | .001 |
| 3 | 60,323 | .593 | .01 |
| 4 | 48,787 | .949 | .16 |
| 5 | 20,714 | 1.289 | .53 |
| 6 | 15,098 | 1.688 | 0.81 |
| 7 | 6,944 | 2.197 | 1.00 |
| 8 | 10,924 | 2.622 | 1.00 |
| 9 | 2,170 | 3.317 | 1.00 |
| 10 | 2,251 | 4.353 | 1.00 |
| 11 | 1,167 | 5.502 | 1.00 |
| 12 | 607 | 6.199 | 1.00 |
| 13 | 278 | 8.054 | 1.00 |
| 14 | 70 | 11.809 | 1.00 |
| 15 | 49 | 12.000 | 1.00 |

If the 35,200 t 1990 TAC is taken, it will induce a fishing mortality of about F=0.40, twice the $F_{0.1}$=0.20 and in fact equal to $F_{max}$. The projected 1991 catch at $F_{0.1}$=0.20 would be 21,000 t. The $F_{0.1}$, 50% rule and constant catch options are summarized in the text table below:

| OPTIONS | F 1990 | F 1991 | Catch ('000 t) 1990 | Catch ('000 t) 1991 |
|---|---|---|---|---|
| 1) $F_{0.1}$ in 1991; | .39 | .20 | 35.2 | 20.7 |
| 2) 50% rule (0.3) in 1991; | .39 | .30 | 35.2 | 30.0 |
| 3) Constant catch at 35,200 t in 1991; | .39 | .36 | 35.2 | 35.2 |

The 1986 and 1987 year-classes are estimated to be above average but their sizes are not precisely estimated. The accumulation of another year's data will allow refinement of the estimates of these two year-classes. CAFSAC is therefore providing catch projections for 1991 only. However, should it be considered desirable to include 4VsW cod in a multi-year management plan, CAFSAC believes that the current TAC of 35,200 t applied for three years would not be detrimental to the resource.

Should the 1990 fixed gear allocations not be reached, as suggested in Section 6.3, CAFSAC believes that uncaught portions should not be transferred to the mobile gear sectors. If transfers occur, they should be made at a substantial discount because any transfers from the fixed gear will reduce the future benefits to the fixed gear from the 1986-1987 year-classes. CAFSAC warns that if rumoured discards did happen and continue to happen, the anticipated stock increases from the 1986 and 1987 year-classes may not accrue or may be smaller than would otherwise be expected.

## 7. COD IN DIVISION 4X

### 7.1. Description of the Fishery

Nominal catches of 4X cod have remained at approximately 20,000 t since 1985. Under joint cod/haddock/pollock (CHP) management, the 1989 nominal catch of 19,585 t substantially exceeded the TAC of 12,000 t. Recent TACs and nominal catches ('000 t) are given below (Fig. 7.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 30 | 30 | 20 | 17.5 | 14 | 12.5[2] | 22 |
| Nominal catch | 25 | 21 | 20 | 19 | 19 | 20 | --- |

[1]Catches are preliminary
[2]Managed under CHP regulation

The nominal catches of both fixed and mobile gear less than 65' exceeded their allocations, even though the fishery was closed to all C1 (mobile gear less than 45') specialists and C2 (mobile gear 45-65') vessels midway through the year. C1 generalists were permitted to fish on a by-catch or trip limit basis for the remainder of the year. Misreporting by the mobile gear less than 65' fleet was believed to be minimal in 1989 in comparison to the high misreporting of 1987 and 1988.

As in recent years, catches were split relatively evenly between mobile gear less than 65' and small longliners of tonnage class 1 and 2. Gillnets accounted for an additional 1,500 t of catch.

Calculation of catch numbers at age was based on samples collected from otter trawl, longline and gillnet catches. Fish of ages 3 and 4 (1986 & 1985 year-classes) made up 74% of the catch numbers and 63% of the catch weight. A comparison of the 1989 catch at age with that predicted for 1989 indicated reasonably good agreement, although the size of the 1985 year-class (age 4) was slightly underestimated. No trends in mean weights at age in the catch have been noted in the past 15 years.

### 7.2. Abundance Indices

*Commercial catch rates*

Misreporting, fishery restrictions (trip limits), and low return rate of logbooks suggest that commercial catch per unit of effort is not a reliable indicator of abundance for this stock.

*Research vessel survey data (Fig. 7.2)*

Survey numbers and biomass for ages 3-7 have remained relatively stable since 1970, although both declined between 1984-87. The 1988 survey appears to be anomalously high with respect to all ages. The 1985 year-class has appeared strong in the last two surveys, the 1987 year-class may also be stronger than average. Conversely, the 1984 year-class has been consistently weak.

The distribution of cod in the surveys from 1970 to 1988 indicate that most are concentrated near the mouth of the Bay of Fundy (on the eastern side) and on the offshore banks. In 1989, the abundance was also higher on the western side

of the Bay of Fundy. Cod greater than 50 cm were more widely distributed than the smaller cod (less than 43 cm) and appeared to be equally abundant in each of the above two regions. Small cod were more abundant in the Bay of Fundy than on the offshore banks.

## 7.3. Assessment

The sequential population analysis was calibrated with ADAPT using the research vessel survey as an index of abundance.

Despite the early closure of the 1989 fishery, fishing mortality has remained high on this stock. The 1989 estimate of F=0.36 is the lowest value in 13 years, and well below the long-term mean of 0.55 (Fig. 7.3). Nevertheless, biomass is increasing rapidly as the very strong 1985 year-class moves through the fishery (Fig. 7.4). The influence of the very weak 1984 year-class has now largely dissipated. The 1984 and the 1985 year-classes make up the weakest and the strongest year-classes, respectively, in 42 years (Fig. 7.5). Despite some uncertainty concerning the absolute strength of the 1985 year-class, its influence is likely to be felt until 1992. The strength of the 1987 year-class remains uncertain, but preliminary results suggest that it is above average. If the strength of the 1987 year-class in 4X parallels that of Georges Bank cod in the same way it did for the 1985 year-class, the outlook for upcoming recruitment is positive.

The results of the 1990 survey are consistent with this assessment. The 1985 year-class is the largest at age 5 since the survey began, while the 1987 year-class is the second largest. There are no indications that the 1990 survey should be considered anomalous; all strata were sampled, no one stratum contributed unduly to the total, and the 1984 year-class is small as expected.

Stock status as indicated by this assessment differs substantially from that of last year. Three factors contributed to the substantial change in perception. First, the strength of the 1985 year-class was underestimated last year, in part because fish of age 3 were not included in the calibration. Second, despite a fishing mortality of F=0.36, the 1989 fishing mortality is about one third less than that of previous years, largely due to the early closure of the fishery. And finally, the rapid growth and early age of recruitment in the fishery magnifies the influence of recruiting year-classes, both with respect to catch composition and population biomass. In the absence of predictions of upcoming recruitment, this problem is likely to continue, making it difficult to react to shifts in population sizes until after they have become pronounced. As an example, during the three years it generally takes to feel confident of a trend in the data, a recruiting year-class of 4X cod will go from a partial recruitment of 10% to fully recruited.

## 7.4. Forecast

CAFSAC estimates that the fishable biomass of 4X cod will remain relatively high through 1991 as the strong 1985 year-class moves through the fishery. Subsequent abundance will depend heavily on the strength of the incoming recruitment.

The following parameters were used in catch projections:

| Age | 1989 Population ('000) | Weight at age (kg) | Partial Recruitment |
|---|---|---|---|
| 1 | 19,904[1] | 0.42 | 0.001 |
| 2 | 15,937 | 0.89 | 0.067 |
| 3 | 18,717 | 1.42 | 0.379 |
| 4 | 26,569 | 2.00 | 0.704 |
| 5 | 2,795 | 2.73 | 1.000 |
| 6 | 2,238 | 3.92 | 1.000 |
| 7 | 344 | 5.25 | 1.000 |
| 8 | 300 | 7.78 | 1.000 |
| 9 | 196 | 9.49 | 1.000 |
| 10 | 62 | 11.00 | 1.000 |
| 11 | 26 | 12.79 | 1.000 |
| 12 | 21 | 15.20 | 1.000 |
| 13 | 3 | 15.40 | 1.000 |

[1]Geometric mean age 1 recruitment, 1948-88

Mean weight and partial recruitment were the mean from 1983-89 and 1983-88 respectively.

Assuming that the 1990 catch will be about 20,000 t, the 1991 catch would be in the order of 19-20,000 t if the 50% rule is applied. Although recruitment for this cod stock occurs too rapidly to include 4X cod in a three-year TAC based management plan, recent TACs appear to have had little influence on the actual tonnage of cod harvested. Therefore, CAFSAC believes that the 1991 to 1993 TACs could be set at about 20,000 t.

## 8. COD IN UNIT AREAS 5Zj and 5Zm

### 8.1. Description of the Fishery

Until 1989, the management units used by Canada for cod in the Gulf of Maine area were those established by ICNAF in the early 1960s. In 1984 the maritime boundary between Canada and the United States was defined and it divided the former management units. In recognition of the divided jurisdiction, a review was undertaken to identify management units which reflected current stock structure and fisheries while allowing Canada to pursue conservation objectives for the long-term benefits of the Canadian fishery. For cod, given practical considerations related to the availability of statistics, the review concluded that cod in unit areas 5Zj and 5Zm could be treated as a distinct unit.

Prior to 1978 when Canada and USA had both extended their jurisdiction on fisheries to 200 miles, there were substantial catches reported by foreign countries, primarily the USSR and Portugal from 5Ze. Since 1978, Canada and the USA are the only countries fishing in 5Zj,m. No TAC has been set for this new management unit and recent landings for Canada and the USA are given

below and in Fig. 8.1. ('000 t):

| | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|
| Canada | 6 | 10 | 9 | 12 | 12 | 8 |
| USA | 11 | 7 | 6 | 5 | 8 | 7 |
| Total | 17 | 17 | 15 | 17 | 20[1] | 15[1] |

[1]Catches are preliminary

Statistics for this new management unit have been calculated for 1978 to the present. Over this period, the maximum catch of 26,000 t occurred in 1982 and the smallest catch was 12,000 t in 1979. Catches have averaged 17,000 t. Catches by both Canada and the USA peak in the summer although catches do occur throughout the year. The USA fishery is almost exclusively an otter trawl fishery while both fixed and mobile gears are involved in the Canadian fishery. The Canadian otter trawler fleet is restricted to a June 1 opening every year.

Total catches in 1989 were about 5,000 t less than 1988 catches primarily because of the early closure of the Canadian otter trawler fishery as a result of the 4X+5 CHP (cod-haddock-pollock) Management Plan. This early closure caused Canadian mobile gear catches to account for only 25% of the Canadian total compared with its usual 60-70% during 1978-1988.

The 1990 Canadian cod fishery on Georges Bank is being managed without TAC. For the otter trawlers control is through a limited number of fishing trips coupled with trip limits and compulsory use of square mesh trawls. Based on reported catches to mid-September, total catches are expected to increase to about 22,000 t for the year with 15,000 t for Canada.

Poor sampling and suspected discarding make it difficult to reliably estimate catch at age for years prior to 1978. Therefore, catch at age was calculated since 1978, using appropriate Canadian and USA sampling of catches and age determinations. As in recent years, the 1985 year-class (40% in numbers) was the most abundant in the 1989 catches. The 1987 year-class was the second most abundant accounting for 27% of the catch numbers. The 1986 year-class made a larger contribution than was expected from the 1988 catches and survey indices. Contrary to most other cod stocks off the Canadian Atlantic, 5Zj,m cod does not exhibit annual trends in size at age.

## 8.2. Abundance Indices

Although commercial catch per unit of effort for both Canada and the USA generally show similar trends with a general decline since 1978, several deficiencies prevent their usage as indices of relative change in abundance.

- The USA catch per unit of effort are not available for 1988-1989.
- The composition of the Canadian otter trawler fleet has changed from primarily large vessels prior to 1982-83 to tonnage class 1-3 since then.
- Trip limits and misreporting combined with a small logbook coverage further compromise the usefulness of the Canadian catch per unit of effort otter trawl data as an index of abundance.

The USA has surveyed the 5Zj,m area in both the spring since 1968 and autumn since 1963 and Canada began a spring survey in 1986. For all three surveys, there are strata which are not entirely within the 5Zj,m area and appropriate adjustments have been made to take this into account.

The surveys were examined for anomalous tows which may have undue influence on the results of the assessment. One such tow was identified for the spring

1982 survey, but its influence is expected to be small. The Canadian 1990 survey abundance estimate is the highest of the five-year series but cod appear to have been more available to the survey trawl in that year compared with previous years. This hypothesis is based on the observation that the abundance of all age-groups increased between 1989 and 1990.

Because the autumn survey results are taken as indices of the following January abundance and the spring survey results are used for the previous January, there are three indices of the age specific January 1990 abundance. All three surveys show similar trends in year-class abundance, with the 1983, 1985 and 1987 year-classes being stronger than average and therefore causing a general increase in abundance since 1987 (Fig. 8.2).

## 8.3. Assessment

Population at ages 1 to 4 and 5+ in 1990 were estimated by calibrating SPA using ADAPT and the three survey indices of abundance. To assess the influence of each survey, additional analyses using combinations of the three survey indices as well as each survey index independently were made. The results suggest that all three survey indices should be included in the assessment.

The results of the assessment indicate that the 1985 year-class was the largest observed with about 30 million age 1 cod (Fig. 8.3). The 1980, 1983 and 1987 year-classes also appear to be well above the average of the 1977 to 1988 year-classes. The 1989 year-class, although not precisely estimated would also be stronger than average. Mid-year age 3 and older biomass in 1990 is about 69,000 t (Fig. 8.4) well above the 1978-1990 average of 49,000 t. Fishing mortality (Fig. 8.5) is estimated to have been F=0.29 in 1989, the lowest since 1978, mostly because of the early closure of the Canadian otter trawl fishery.

To investigate whether there were anomalies in the assessment which resulted from assessing 5Zj,m as a separate entity, the results were compared with those of a 5Ze assessment. The trends in biomass and fishing mortality were similar between the total 5Ze assessment and the 5Zj,m assessment therefore suggesting that no anomalies were introduced in the assessment although there were indications of higher exploitation rates outside the 5Zj,m area.

## 8.4. Forecast

The following input data were used to calculate catch projections.

| Age | 1990 Beginning of Year Population Numbers ('000s) | Mean Weight (kg) | Partial Recruitment |
|---|---|---|---|
| 1 | 9,959 | 0.696 | 0.004 |
| 2 | 6,978 | 1.391 | 0.299 |
| 3 | 9,659 | 2.249 | 1.000 |
| 4 | 1,611 | 3.579 | 1.000 |
| 5 | 6,465 | 5.012 | 1.000 |
| 6 | 556 | 6.448 | 1.000 |
| 7 | 647 | 8.333 | 1.000 |
| 8 | 78 | 10.340 | 1.000 |
| 9 | 133 | 10.948 | 1.000 |

As indicated earlier, the results of the assessment suggested that the 1989 year-class was stronger than average. However, because the estimate is imprecise, the 1989 year-class was assumed to be equal to the geometric mean for the 1977 to 1988 year-classes.

If the expected catches of 22,000 t are taken in 1990, the fishing mortality will be about F=0.39, well above $F_{0.1}$ but similar to values in recent years. Age 3 and older biomass would decline by about 10,000 t to 59,000 t in January 1991.

CAFSAC is providing catch projections at two fishing mortalities for 1991, $F_{0.1}$, F at the 50% rule and the 1991 catch equal to the expected 1990 catch. These catch projections are for both the USA and Canadian fleets. The results are given in the text table below:

| Option | F(3+) | | Catch('000t) | |
|---|---|---|---|---|
| | 1990 | 1991 | 1990 | 1991 |
| 1) 22,000 t in 1990, $F_{0.1}$ in 1991 | .39 | .20 | 22 | 11 |
| 2) 22,000 t in 1990, 50% rule in 1991; | .39 | .30 | 22 | 16 |
| 3) 22,000 t in 1990 and 1991 F=0.43 | .39 | .43 | 22 | 22 |

CAFSAC believes that fishing mortality should not be allowed to increase above estimated 1990 values. This would imply catches of about 20,000 t in 1991.

Cod in 5Zj,m are fully recruited at age 3 which implies that catch forecasts are heavily dependent on estimates of or assumptions about incoming recruitment. Although the 1985 and 1987 year-classes will likely continue to contribute substantially to the catches in 1991, it is not possible to precisely forecast catches in the context of a multi-year management plan because recruitment is variable and unpredictable and will have a large influence on actual catches.

Studies are underway to estimate the relative biomasses on each side of the international boundary in 5Zj,m. When these studies are completed, it will be possible to advise on the proportion of total biomass in 5Zj,m which would be available to the Canadian fleet.

## 9. HADDOCK IN DIVISIONS 4T, 4V AND 4W

### 9.1. Description of the Fishery

From 1950 to 1969, catches averaged about 26,000 t while the fishery became almost non-existent in the early 1970s. From 1970 to 1979, catches averaged about 5,000 t. In the 1980s, catches varied between 4,000 and 22,000 t. The nominal catches for 1987 through 1989 have been taken exclusively as by-catch in other groundfish fisheries operating in Divisions 4T, 4V, and 4W, and totalled 7,750 t in 1989. This represents a 16% overrun of the advised TAC of 6,700 t for 1989.

Recent TACs and catches ('000 t) are given below (Fig. 9.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 15 | 15 | 17 | -[2] | -[2] | 6.7 | 6.0 |
| Nominal catch | 8 | 11 | 17 | 4.0 | 4.5 | 7.8 | - |

[1]Catches are preliminary
[2]No TAC - by-catch only

In 1986, the combination of poor recruitment over several successive years (1983-1985), low spawning stock biomass, and the concentration of the fishery on the only two remaining year-classes of any appreciable size (that of 1981 and 1982), resulted in the restriction of the fishery to by-catches. In 1987 the maximum by-catch was 5%; this was increased to 10% in 1988, and 15% in 1989. Management also imposed a year-round ban on mobile gear fisheries in areas identified as nursery grounds (mainly Western and Emerald banks). These nursery ground closures remain in effect to the present.

Until 1984, most of the catch from this stock was taken in Division 4W by large otter trawlers (tonnage class 4 and 5) fishing in the spring. From 1984 to 1986 Subdivision 4Vs accounted for an increasing proportion of the total catch. Since the restriction of the fishery in 1987, mobile gear landings in 4Vs have about doubled while fixed gear landings in 4W have increased approximately four-fold. During this period otter trawls have landed between 52 and 56% of the landings each year while longliners have increased their share from 19 to 29% mainly as a result of increased catches in 4W. Longline landings in 4W in 1989 exceed longline landings observed there in 1986, prior to the restriction of the fishery. Seine catches have declined from 15 to 6% of the annual total.

In 1989 there were some indications that haddock reported as caught in 4W may actually have been caught in 4X. This was the result of an early closure of the 4X fishery prompting some fishermen to obtain conditions of licence allowing them access to 4W, but continuing to fish in 4X while reporting their catches from 4W. Early in 1990 there have also been reports of haddock caught in Subdivision 4Vs being reported from Subarea 3. None of these reports indicate the quantities of fish involved.

*Catch and weight at age*

The age compositions of the 1989 foreign and Canadian catches were estimated in a manner consistent with recent practices. The Canadian catch at age in 1989 was composed primarily of the 1984 and 1985 year-classes (33.4% and 25.1% by numbers respectively) which made up 58.5% of the total numbers caught. By weight these year-classes accounted for 74.7% of the total catch (1984 = 47.6% and 1985 = 27.2%).

The foreign fishery in 1989 caught 680 t, approximately twice the catch in 1988. This catch contained large numbers of fish at age 1 and 2. Since this fishery is restricted to operate seaward of the small mesh gear line, the catch of small fish is not related to a change in location of the fishery. Furthermore, catches of haddock are usually avoided since the entire silver hake fishery is restricted to a 1% aggregate by-catch and the fishery is closed once this limit has been reached. This indicates that these catches may have been unavoidable as a result of the overall abundance of the 1987 and 1988 year-classes. The 1988 year-class accounted for 20% of the total 1989 catch by numbers and 1.6% of the catch by weight, while the 1987 year-class represented 9% by numbers and 2.8% by weight.

A comparison of the observed and projected catch at age for 1989 reveals discrepancies at ages 1 and 2 as a result of the small mesh gear catches. Catches at ages 3 to 5 are in relatively close agreement, while those at ages 6 and 7

show that significantly fewer fish were caught than were projected from last years assessment.

The maximum age in the catch has diminished from age 11 in 1984 to age 9 in 1989.

## 9.2. Abundance Indices

*Commercial catch rates*

The by-catch nature of this fishery since 1987 does not allow for a comparison of present catch rates with those of earlier years from directed fisheries.

*Research vessel survey data*

The research survey catch rates from 1970 to 1988 show a decline in overall abundance from 1983 to 1987 with a subsequent increase in 1988 and a slight decline to 1989 (Fig. 9.2). The sharp increase in 1988 is due mainly to a large catch of 2 year old fish (the 1986 year-class) in a single stratum. The 1989 estimate of this year-class shows it to be much smaller. The 1989 catch rate is still higher than that of 1987. The estimate of the 1988 year-class at age 1 shows an abundance similar to that of the abundant 1980 or 1981 year-classes and appears to be relatively well estimated.

In an attempt to better understand the dynamic of this haddock stock, CAFSAC undertook a detailed analysis of the geographical distribution of survey catches. Division 4W has traditionally been the centre of distribution of this resource as indicated by the significantly higher catch per set observed (Fig. 9.3). Age 0 fish have been observed in 13 of the past 20 years while age 1 fish are present in all years. Catches of fish aged 0-3 increased after 1977, following the exclusion of the foreign fleet. The peak in recent catch rates occurred in 1983 because of the presence of the large 1980-1982 year-classes. Catch rates at these younger ages declined from 1983 to 1987 as a result of lower recruitment and have shown an unsteady increase over the past two years. Catch rates at ages 4+, which peaked in 1984 continue to decline to the present.

The survey age composition in Subdivision 4Vn is dominated by ages 4+ (Fig. 9.4). Age 0 fish have not been observed in the survey of this area, while fish at ages 1-3 have occurred in less than 50% of the surveys. Catch rates show clearly the influx and subsequent decline of the 1980-1982 year-classes beginning in 1984. Since these three large year-classes there has been no significant recruitment to this part of the population. It should be noted that catch rates in 4Vn have been higher since the influx of the 1977 year-class in 1981 than for the preceding ten years. This year-class would have been the first one to benefit from the exclusion of the foreign fleets from the Scotian Shelf.

Subdivision 4Vs shows the presence of age 0 fish in a single year since 1970 when some fish belonging to the large 1982 cohort were found there. Age 1 fish have been observed in 16 of the past 20 years. Catch rates increased rapidly in 1982 as a result of the incursion of fish belonging mainly to the 1981 year-class (Fig. 9.5). These high catch rates have declined to pre-1982 values by 1989. As was the case in 4Vn, the presence of post 1977 year-classes became evident in the early 1980s. Since 1987, catch rates at ages 4+ have declined rapidly to the present.

The maximum age observed in the survey has been declining since the early 1980s. In 1989 the oldest fish in the survey were age 7 while in the early 1980s fish at ages 10 and 11 were observed with some as old as age 15.

*Closed Area*

A haddock nursery area has been closed year-round to mobile gear fisheries since 1987. The objective of the closed area is to protect incoming recruits from fishing to allow this stock to rebuild. Areas identified for closure were those which showed persistent and relatively large aggregations of young fish in the July survey series. The area encompasses all of Western and Emerald banks and extends seaward to the small mesh gear line. Fixed gear fisheries are permitted to fish inside this closed area (subject to all other regulations in effect) since these gears catch relatively older fish than mobile gear.

It is too early to establish a direct cause and effect relationship between the closed area and a subsequent change in resource status. However, in the surveys, catch rates at ages 1 and 2 of fish belonging to the 1987 and 1988 year-classes were higher than the 1983 through 1986 year-classes at these ages. These two year-classes are the first which may have benefitted from the effects of the closed area.

An age structured analysis of the spatial distribution of haddock shows that the closed area may also be the center of distribution of all age classes from age 0 to 8. This is based on the observation that the mean catch per tow at age in this area is above the overall average catch per tow at age more frequently than elsewhere in the stock area for all of these ages. The overall average catch per tow at age was calculated across all strata and years of the survey. These analyses also indicated that haddock become more widely distributed with age and abundance. Abundant year-classes were also found to be more widely distributed than small year-classes. An examination of the 1987 and 1988 year-classes at ages 1 and 2 show them to be more widely distributed than those of 1983 through 1986. These results are preliminary and the conclusions may apply only to the summer period. A similar analysis for 4X haddock suggests that the centres of distribution are persistent over seasons.

## 9.3. Assessment

As was the case in last year's assessment, CAFSAC was unable to reliably calibrate sequential population analysis. Several attempts have been made using either whole or half year data and examining the impact of using sequentially longer time series. In all cases, the estimated fishing mortality for a given year increased when other years were added to the data series. These results cast doubts on the validity of the estimated fishing mortality in the current year, whatever the current year is.

The data show clearly however that very few haddock survive to become older than age 4. There are indications that haddock in this area are dying faster than can be accounted for by catches. Several factors could account for or contribute to this phenomenon:

- larger, older haddock could migrate out of the stock area; and
- larger, older haddock could experience higher natural mortality.

Neither tagging results nor current knowledge of haddock biology support these two possibilities but they cannot be ruled out. A third hypothesis, which follows, is not easily verified:

- greater numbers of haddock are caught than are reported because of discarding, misreporting or non-reporting.

*Fishing mortality and stock abundance*

Total mortalities estimated from survey catch rates at age indicate that fishing mortality in recent years is well above $F_{0.1}$=0.25 (Fig. 9.6) and has been

increasing since the early to mid-1980s. Given the variability in survey catch rates, these estimates while indicating the overall trend in F, should be viewed as approximate. The mean weight of a fish in the catch in 1989 also points to an exploitation rate well in excess of $F_{0.1}$ (Fig. 9.7).

*Recruitment*

Results of the 1989 July research survey indicate that the 1988 year-class appears to be relatively strong. Its wide distribution over the stock area is similar to that of previously observed large year-classes. The 1987 year-class does not appear to be as large as that of 1988 but may be larger than the 1983 through 1986 year-classes. The 1987 and 1988 year-classes also appeared strong in the small mesh gear fishery.

## 9.4. Forecast

Several observations suggest that this stock has and still is being heavily exploited. Survival rates estimated from surveys are low and the average weight in the commercial catch also suggests high exploitation, consistent with the reduction in age-span seen in the survey. CAFSAC concludes that present regulations do not appear to have decreased exploitation. A reduction in mobile gear by-catch from 15 to 5% would be helpful in that regard. The present closed area should be maintained year-round to protect the 1987-88 year-classes from fishery related mortality. Considering the low abundance of 4TVW haddock and the fact that any strong incoming year-class should be protected, CAFSAC suggests that the proposed management measures be applied during 1991 to 1993. CAFSAC will monitor the fisheries closely and should events warrant a change in management measures, advice to that effect will be promptly provided.

# 10. HADDOCK IN DIVISION 4X

## 10.1. Description of the Fishery

The long-term (1930-1983) reported annual landings have averaged about 20,000 t. This level was surpassed during the mid to late 1960s and again during the 1980s when landings peaked above 30,000 t. High catches in the 1960s were based mainly on the strong 1963 year-class, and resulted in high exploitation rates and low spawning stock biomass. For these reasons, quota regulation and spawning area closure were imposed in 1970 as recommended by ICNAF. The 1970 TAC was set at 18,000 t, but was dropped to 9,000 t in 1972 with ICNAF further recommending closure of the fishery in 1974. Catches and TACs subsequently increased to a peak in 1981-82. Catches were lower than TACs during 1982-84. Total catch has been below the long-term average since 1984 with restrictive quotas in place since 1985.

There has been a general tendency over time for finer and finer subdivision of the TAC by fleet sector and season. During 1982-87, the fishery was regulated on the basis of five gear sectors: 1) mobile gear less than 65 ft; 2) mobile gear 65-100 ft; 3) mobile gear greater than 100 ft; 4) fixed gear less than 65 ft; and 5) fixed gear 65-100 ft. In 1988, the less than 65 ft gear sectors were further subdivided into less than and greater than 45 ft (ie. fixed gear less than 45 feet (A1) and more than 45 feet (A2) and mobile gear tonnage class 1 and 2). In 1989, mobile gear less than 45 ft (tonnage class 1) were further split into generalists and specialists. These fine-scale allocations resulted in significant enforcement problems. In an attempt to resolve catch reporting by species, an aggregate cod/haddock/pollock (CHP) quota system was implemented in 1989 for the mobile gear fleet less than 65 feet. In 1986, the allocation to the mobile gear was subdivided into three 4-month periods to extend the fishery throughout the year. This continued until 1989 at which time the mobile gear sector (tonnage class 1 specialists and tonnage class 2), in deciding to forego the four-month allocation system, exceeded their total CHP allocation and were shut down by the

end of June. The fixed gear sectors operated until early October at which time they went on by-catch status. In 1989, mobile gear less than 45 ft (tonnage class 1) caught 150% of their haddock allocation, mobile gear 45-65 ft (tonnage class 2) caught 130% of their haddock allocation and fixed gear less than 65 ft caught 187% of their haddock allocation. Landings by vessels greater than 65 ft were approximately 65 t.

Recent nominal catches, and TACs ('000s t) are (Fig. 10.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 32.0 | 15.0 | 15.0 | 15.0 | 12.4 | 4.6 | 4.6 |
| Nominal catch | 19.6 | 14.9 | 15.0 | 13.6 | 11.0 | 6.7 | - |

[1]Catches are preliminary

Discussions with industry representatives have indicated that substantial misreporting occurred during 1985-88. This was further corroborated by examination of anecdotal information which showed that misreporting occurred anytime in the past when quotas have been restrictive. However, it is not possible to quantify the level. This information indicated that in 1989 misreporting was generally low compared to previous years since the fishery was initially unrestricted during that period under the CHP quota system.

*Catch and weight at age*

Sampling of the fishery during 1989 was adequate to construct the catch at age, which was done following previous practices. As in previous years, no adjustments were possible to the total landings to account for misreporting.

In recent years, there has been a tendency for the landings to be dominated by fewer and fewer age groups. In 1982-83, five age groups (3-7) each contributed over 10% by weight to the total yield. In the following two years, four age groups dominated. During 1986-89, only three age groups have contributed significantly to the annual landings. Since 1985, older fish have become relatively rare in the catch at age and this is a sign of poor survival and the general trend in recent years is consistent with decreased abundance.

## 10.2. Abundance Indices

*Commercial catch rates*

Because of misreporting, the commercial catch per unit of effort is not considered to be a reliable index of haddock abundance in NAFO Division 4X.

*Research vessel survey data*

The July groundfish research survey on the Scotian Shelf from 1970-89 was used to evaluate the status of the resource. The arithmetic mean catch rates from 1970-89 for all age groups combined exhibit large inter-annual variability. Trends in weight per tow paralleled catch in numbers per tow, except for the last three years where biomass seemed to decline faster which is an indication of a preponderance of smaller fish (Fig. 10.2, 10.3). In general, total abundance was low during the early 1970s and high during the early-mid-1980s. Biomass dropped sharply during 1985-1988 and has remained low in 1989. There has also been a reduction in recent years in the number of ages seen in the survey, a trend consistent with that observed in the commercial fishery. Abundance of the 1985 and 1986 year-classes appear particularly low, possibly equalling the size of the 1970 year-class, which was the lowest on record. The abundance of the 1987 year-class at age 2 in 1989 is encouraging, and parallels a strong 1987 year-class on Georges Bank.

### 10.3. Assessment

Estimates of survival from the research surveys are low for fish fully recruited to the survey (ages 5 to 8). CAFSAC was unable to calibrate the sequential population analysis largely because of the poor quality of the input data. The attempts made indicated that, similar to 4TVW haddock, the estimated fishing mortalities for a given year increased as other years were added to the data series. Other problems encountered were a steady increase in availability to the survey with age and the changes in reporting practices.

The inconsistencies encountered when attempting to calibrate the sequential population analysis suggest that fish are dying faster than can be accounted for by catch. Several factors could account for or contribute to this phenomenon:

- larger, older haddock could migrate out of the stock area;
- and larger, older haddock could experience higher natural mortality.

Neither tagging results nor current knowledge of haddock biology support these two possibilities but they cannot be ruled out. A third hypothesis, which follows is not easily verified:

- greater numbers of haddock are caught than are reported because of discarding, misreporting or non-reporting.

Despite not being able to calibrate sequential population analysis, there are clear signs that the stock is experiencing very high fishing mortalities as shown by the reduction in the age range in the commercial catch and low survival in the surveys.

### 10.4 Forecast

CAFSAC believes that this assessment shows that there has been no increase in abundance compared with the previous assessment and stock recovery is very unlikely with present catches. Considering the low biomass of 4X haddock and the fact that any incoming year-class should be protected, CAFSAC suggests that there be no directed fishery and that by-catch regulation be applied for 1991-1993. These by-catches should be kept to the lowest possible level. CAFSAC will monitor the stock closely and should stock increases allow for a directed fishery, advice to that effect will be promptly provided.

## 11. HADDOCK IN UNIT AREAS 5Zj and 5Zm

### 11.1. Description of the Fishery

Until 1989, the management units used by Canada for haddock in the Gulf of Maine area were those established by ICNAF in the early 1960s. In 1984 the maritime boundary between Canada and the United States was defined and it split the former management units. In recognition of the divided jurisdiction, a review was undertaken to identify management units which reflected current stock structure and fisheries while allowing Canada to pursue conservation objectives for the long-term benefits of the Canadian fishery. For haddock, given practical considerations related to the availability of statistics, the review concluded that haddock in unit areas 5Zj and 5Zm could be treated as a distinct unit.

The haddock on Georges Bank have supported an important commercial fishery since the early 1920s. Before the 200 mile limit was imposed in 1977 there was a strong foreign presence with many countries fishing small mesh directed at species other than haddock. However, since 1977 only Canada and the USA have had

fisheries on Georges Bank, with each being restricted to their respective side of the maritime boundary since it was established in 1984.

High catches were taken in the mid-1960s (roughly 60,000 t) from 5Zj,m which exploited the exceptional 1963 year-class. Since then catches declined to a low of 2,400 t in 1976. Catches climbed to 19,000 t in 1980 and have declined to 3,800 t in 1989 when the fishery was closed to trawlers after only a few weeks. Although historically 5Zj and 5Zm have contributed about 40% of the total catch from Georges Bank, in recent years almost all of the haddock catch has been taken in these two unit areas.

The USA fishery has existed since the early 1900s and has been predominantly a trawler fishery for groundfish, haddock being one of the more important species. In the past the fishery has been fairly evenly distributed throughout the year but in recent years it has been concentrated during the first half of the year. The USA catch in 5Zj,m dropped to a record low of 787 t in 1989 which reflects the absence of a directed commercial fishery for haddock.

The Canadian fishery did not start making significant catches until the mid 1960s. It is mainly an otter trawl fishery but has a substantial longline component. This fishery occurs from mid-summer to early fall because of the June opening of the trawler season. Until 1984 tonnage class 5 dominated the fishery but since then tonnage classes 2 and 3 have been predominant.

The Canadian quota in 1987 and 1988 was set at 8,300 t. A combined cod-haddock-pollock quota was used for 4X-5Zc in 1989. The Canadian otter trawl fishery in that year was stopped after only a few weeks of activity when quota limits were reached. Trip limits and a limit on the number of trips have been employed during 1990 without any quota. As well, in July tonnage class 1-3 vessels were required to change to square mesh gear and to carry a DFO observer. Anecdotal information from the 1990 fishery has reports of fairly good catches of large haddock. Data from the observers comparing square and diamond mesh indicate low haddock discard rates for both gear: 1.36% for diamond vs. 0.08% for square mesh. A similar size distribution was caught by 130 mm diamond and 130 mm square mesh nets while the 140 mm square mesh indicates less retention of small haddock than the 140 mm diamond-mesh.

Since this is a new management unit, there are no past TACs. Recent catches ('000 t) are as follows (Fig. 11.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] |
|---|---|---|---|---|---|---|
| Nominal catch | | | | | | |
| Canada | 1.5 | 3.5 | 3.4 | 4.7 | 4.0 | 3.1 |
| USA | 5.1 | 1.7 | 2.2 | 1.4 | 1.7 | 0.8 |
| Total | 6.6 | 5.2 | 5.6 | 6.1 | 5.7 | 3.8 |

[1]Catches are preliminary

Catch at age was calculated, starting in 1969, using appropriate Canadian, USA and foreign sampling of catches and age determinations. Discards were estimated from interviews and, based on an atlas of USSR fishing activity, 40% of the small mesh landings in 5Z were assumed to have come from 5Zj,m.

In recent years, year-classes have made different contributions to the Canadian and USA fisheries. In the Canadian fishery, the largest catches generally occurred at age 2 and the 1983, 1985 and 1987 year-classes have been dominant. In the USA fishery, the 1983 year-classes has dominated until 1988 and the 1985 and 1987 year-classes do not appear to have been particularly strong. Because Canada has taken by far the largest share of the catches after 1985, the combined catch at age for recent years is very similar to the Canadian age composition.

## 11.2 Abundance Indices

Changes in the fleet composition, poor logbook coverage and misreporting render the commercial catch per unit of effort of little use as relative indices of changes in stock sizes.

Annual groundfish surveys have been conducted in this area by Canada during the spring since 1986 and by the USA during the spring since 1968 and during the autumn since 1963. For all three surveys, there are strata which are not entirely within the 5Zj,m area and appropriate adjustments have been made to take this into account.

All three surveys were able to detect the strong 1983, 1985 and 1987 year-classes. The Canadian survey shows these three year-classes to be stronger than the USA spring survey suggests. The 1987 autumn USA survey results appear anomalously low compared with neighbouring years, probably because of reduced availability. Both spring surveys increased in 1990 (Fig. 11.2).

## 11.3. Assessment

The results of a 5Z haddock assessment were compared with those of this assessment for the 5Zj,m area. The comparison did not reveal anomalies which would prevent doing an assessment for 5Zj,m.

Population at ages 1 to 4 and 5+ in 1990 were estimated by calibrating SPA using ADAPT and the three survey indices of abundance. Similar to 5Zj,m cod, combinations of the three survey indices as well as each survey independently were used to assess the influence of each index on the resulting assessment. The results suggests that all three surveys should be included in the assessment.

The adult population biomass appears to have recovered somewhat from the extremely low values it had reached during the early 1970s and again in the mid 1980s (Fig. 11.3). The recent increase has been supported by the recruitment of the 1983, 1985 and 1987 year-classes (Fig. 11.5). The reduction in fishing mortality rate (Fig. 11.4) during 1989 was because of the closure of the Canadian mobile gear fishery. It is interesting to note that the longliners alone were able to generate an exploitation rate approaching $F_{0.1}$. Fishing mortality since the maritime boundary was established, has averaged about 0.3, somewhat higher than the $F_{0.1}$=0.25. The closure of the mobile gear fishery in 1989 was a major factor in conserving the 1987 year-class until it had realized some growth potential. The change to square mesh should be a positive factor in conserving future year-classes at age 2. The analyses confirmed that the 1983, 1985 and 1987 year-classes, while not as big as the 1975 and 1978 year-classes were considerably better than recent recruitment. There are indications that the 1989 year-class is promising but it is too early to predict it with any confidence.

### 11.4. Forecast

Projections to 1991 were calculated using the following input data:

| Age | January 1990 Population numbers (000s) | Average[1] Weight | Partial[2] Recruitment |
|---|---|---|---|
| 1 | 7,763 | 0.44 | 0 |
| 2 | 531 | 0.89 | 0.5 |
| 3 | 12,174 | 1.40 | 1 |
| 4 | 240 | 1.82 | 1 |
| 5 | 3,289 | 2.12 | 1 |
| 6 | 376 | 2.49 | 1 |
| 7 | 1,238 | 2.85 | 1 |
| 8 | 100 | 3.83 | 1 |

[1]Average for 1987-89
[2]Partial recruitment used in yield per recruit analysis

The catch in 1991 at $F_{0.1}$=0.25 would be 5,400 t if the 1990 expected catch of 5,900 t, which also corresponds to $F_{0.1}$ for that year is not exceeded. The adult population biomass will decrease in 1991 and subsequent improvement will depend on the strength of the 1989 year-class. The 1991 projected catches are also heavily dependent on the size of 1989 year-class. CAFSAC will attempt to refine its estimate of the size of the 1989 year-class in June 1991 when additional survey information has been considered.

It is not possible to reliably calculate catch projections for several years in advance in a fishery like this where yearly catches depend heavily on recruitment and recruitment itself is highly variable from year to year. If the change to a square mesh and decreased fishing pressure result in more ages contributing to the catches, then catch projections in the context of a multi-year management plan may become possible. Although it is not possible to provide catch projections in the context of a multi-year management plan, advice framed in term of fishing effort is possible in such a context. The exploitation rate in recent years has been about 30% above the $F_{0.1}$ target and because the exploitation rate is directly related to the fishing effort, this implies that recent fishing effort has been too high by about 30% and long-term management should aim at reducing effective fishing effort by about 30%.

## 12. POLLOCK IN DIVISIONS 4V, 4W, 4X AND SUBDIVISION 5Zc

### 12.1. Description of the Fishery

Since 1982, the pollock fishery has been regulated by quotas on four gear sectors: 1) fixed gear, 2) mobile gear greater than 100 ft, 3) mobile gear 65-100 ft, and 4) mobile gear less than 65 ft. In 1988, mobile and fixed gear less than 65 ft were further divided: a) mobile and fixed gear less than 45 ft, and b) mobile gear and fixed gear 45 - 65 ft. Seasonal quotas and trip limits were introduced in 1986 for mobile gear under 65 ft in order to extend the fishery to the end of the year.

For vessels less than 65 ft in southwest Nova Scotia, the 1989 management plan combined the quota for Division 4X and Subdivision 5Zc cod and haddock and divisions 4VWX and Subdivision 5Zc pollock into a single combined quota cod/haddock/pollock. The fishery was limited by the aggregate total and individual quotas for cod and haddock were exceeded. By removing the landing restrictions from the individual species, the 1989 management plan was intended to address the problems of misreporting by species and area. While reported catch was thought to be more accurate in the early months of 1989, discarding

pollock in favour of more valuable cod and haddock was thought to be a serious problem in unconfirmed industry reports. The fleet less than 45 ft was further split in 1989 into specialist and generalist categories. These two fleets and the 45 to 65 ft fleet were regulated through license condition and trip limits. For 1989, the license condition generally replaced the variation order as a means of regulating the fishery. Under the 1989 management plan, the Divisions 4X and Subdivision 5Zc mobile gear fleet, 45 - 65 ft and the under 45 ft specialist, was closed by June 29th.

The pollock fishery is prosecuted mainly in Division 4X and Subdivision 5Zc with a smaller proportion being taken in Division 4VW, although there has been a shift in the Division 4VW fishery from Division 4W to Division 4V during 1984-1989. Division 4V landings have increased from about 5,000 t in 1984 to an average of 13,000 t for the 1985-1989 period. The fishery in Division 4VW is dominated by large offshore vessels greater than 100 ft with mobile gear and in Division 4X and Subdivision 5Zc by inshore vessels less than 65 ft with mobile and fixed gear.

Landings have been relatively stable since 1985 in response to the good recruitment of the 1979-83 year-classes. Recent catches and the TAC for 1990 are as follows ('000 t) (Fig. 12.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC[2] | | | | | | | 43 |
| Nominal catch | 35 | 44 | 44 | 46 | 43 | 43 | - |

[1]Catches are preliminary
[2]New management unit, first TAC in 1990

*Catch and weight at age*

Catch and mean weight at age for the 1989 landings were estimated using samples from the commercial fisheries. The 1982-1985 year-classes were dominant accounting for 82% and 77% of the catch in number and weight respectively. The 1979 year-class at age 10 was 3% of the catch, the highest value observed at that age since 1970. Differences were noted in the age composition of the large trawler catch between Divisions 4VW and Division 4X and Subdivision 5Zc. Weight at age was similar to that observed in recent years.

## 12.2 Abundance Indices

*Commercial catch rates*

As noted last year, the catch rate trend is not consistent with observations of incoming recruitment that is the 1979-83 year-classes and their effect on fishable biomass in subsequent years. In addition, trip limits adopted by industry were thought to impact catch rates. Therefore, CAFSAC considered that these recent catch rates are not representative indices of abundance for this stock.

*Research vessel survey data (Fig. 12.2)*

Research surveys from 1974 to 1989 indicate an increase in the age 4-9 abundance from the early 1980s with the 1985 and 1987 numbers among the highest observed. Since the early 1980s, the survey data also show an increase in pollock abundance in divisions 4VW, notably the Gully and inshore Division 4W, with abundance in Division 4X remaining relatively constant. The 1984 and 1985 year-classes appear to be at least average, but the survey provides little information as to the size of subsequent year-classes.

## 12.3. Assessment

The sequential population analysis was calibrated using ADAPT and the research vessel survey population estimates at age 4 to 9. There are indications that older fish (ages 10-11) are exploited more lightly than middle ages (about 50% of ages 7 to 9).

The 1979 and the 1982 year-classes at age 2 are the largest observed in the 1974-1989 period at 83 and 54 million respectively (Fig. 12.3). The 1980, 1981 and 1983 year-classes are all above the long-term average of 31 million while the 1984 and 1985 year-classes are average. The 1986 and 1987 year-classes are relatively weak. Mid-year biomass for ages 2 and older has increased since 1983 reflecting the strong 1979-1983 year-classes and is currently at a relatively high level (Fig. 12.4). Population numbers age 4-9 have increased since 1982 and are presently at about their maximum (Fig. 12.5). Fully recruited fishing mortalities have been fluctuating with a decreasing trend toward $F_{0.1}$ (0.31) for almost the entire series and are currently estimated to be slightly below the $F_{0.1}$ target level (Fig. 12.6).

These results, of course, are directly dependent on the reported catches. If over-reporting of pollock has occurred in the past, the estimates of stock sizes based on over-reported catches would be higher than the actual stock population.

Because of the estimated change in the exploitation pattern over ages, (older fish being exploited more lightly than middle ages) the target fishing mortality at $F_{0.1}$ has been recalculated using yield-per-recruit analyses. When it was estimated that all pollock older than age 7 were equally exploited, the $F_{0.1}$ target fishing mortality was F=0.25. With the new estimates of exploitation pattern over ages, the results indicate that $F_{0.1}$ is about 0.31 for ages 7 to 9, where the fishing mortality is maximum, and would decline for ages 10 and older. Overall, the average fishing mortality on ages 7 and older pollock would still be about 0.25 except that ages 7 to 9 experience higher fishing mortalities than the older ages do.

## 12.4 Forecast

The following input data were used to calculate catch projections.

| Age | 1990 Beginning of year population | Weight[1] (kg) | Partial[2] Recruitment |
|---|---|---|---|
| 2 | 31,000 | .80 | .01 |
| 3 | 25,335 | 1.32 | .19 |
| 4 | 20,281 | 1.93 | .49 |
| 5 | 14,098 | 2.54 | .80 |
| 6 | 8,884 | 3.17 | 1.00 |
| 7 | 12,686 | 3.65 | 1.00 |
| 8 | 7,166 | 4.13 | 1.00 |
| 9 | 3,201 | 4.85 | .85 |
| 10 | 1,832 | 5.69 | .67 |
| 11 | 1,622 | 7.09 | .50 |

[1] 1986 - 1989 average
[2] 1977 - 1986 average

The 1989 and 1990 year-classes at age 2 were set to the 1974-1987 geometric mean of 31 million fish. Catch projections to 1993 were done under two different management scenarios. Results of the projections are as follows:

| | F | | | | Catch ('000 t) | | | |
|---|---|---|---|---|---|---|---|---|
| OPTIONS | 1990 | 1991 | 1992 | 1993 | 1990 | 1991 | 1992 | 1993 |
| 1) $F_{0.1}$ in 1991-93 | .29 | .31 | .31 | .31 | 43 | 41 | 38 | 35 |
| 2) Constant catch in 1991 to 1993 | .29 | .32 | .37 | .41 | 43 | 43 | 43 | 43 |

In view of these results, CAFSAC considers that catches of about 40,000 t for 1991 to 1993 would likely be difficult to distinguish from $F_{0.1}$. CAFSAC will monitor the fishery closely and should a change in catches be considered necessary, advice to that effect will be promptly provided.

# 13. REDFISH IN SUBAREA 2 AND DIVISION 3K

## 13.1. Description of the Fishery

Historical nominal landings have ranged from 187,000 t in 1959 to 19,000 t in 1987. However, the 1988 and 1989 catches were only 7,000 and 3,000 t respectively. The recent decline can be explained by low catch rates which did not allow a cost effective operation, high percentage of external parasites and bacterial infestation of the flesh resulting in unmarketable fillets. As well, there has been no directed trips by Japanese and USSR vessels for the Resource Short Plant Program since 1987.

Since the early 1980s, the fishery has been concentrated in Division 3K. This was attributable to a variety of factors, including ice cover early in the year in Division 2G and 2H and prevalence of external parasites Sphyrion in Division 2J. Landings are distributed throughout the year and are predominantly taken by otter trawl.

Recent nominal catches and TACs ('000 t) are as follows (Fig. 13.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Nominal catch | 24 | 29 | 27 | 19 | 7 | 3 | - |

[1]Catches are preliminary

The most abundant lengths in the catch were in the range of 29-35 cm corresponding to the year-classes of the early 1970s.

## 13.2. Abundance Indices

*Commercial catch rates (Fig. 13.2)*

The catch and effort data for 1959 to 1989 were analyzed using a multiplicative model to derive a standardized catch rate series. The resulting catch rate shows an increase from 1959-64 followed by a decrease to the lowest value estimated in 1973. A period of stability occurred from 1975 to 1981 followed by a steady increase to 1984 and a general decrease since then. CAFSAC concludes that the decline in catch rates in recent years may not be indicative of a reduction in stock biomass but may be an artifact of the limited fishing effort exerted in recent years.

*Research vessel survey data (Fig. 13.3)*

Stratified random surveys have been carried out in the autumn in Division 2J and Division 3K since 1977. A multiplicative model was used to obtain estimates of mean numbers and weights per tow for strata not sampled in any particular year. The historical series of mean numbers and weight from the surveys suggest a downward trend both in Division 2J and Division 3K since the early 1980s. Stratified mean number and weight per tow for Division 2GH in years when surveys were conducted, indicate a lower abundance in these more northern divisions. The length frequencies and population numbers at age estimates from the autumn surveys indicate that recruitment has been relatively poor since the surveys began in 1977.

## 13.3 Assessment

Redfish stocks are not easily assessed using sequential population analyses techniques because the exploitation rates are low and the exploitation pattern over age is difficult to estimate. Most often, stock sizes and future catches are estimated from general production models which are based on catch and effort data. Using these methods on 2+3K redfish resulted in potential catch estimates which were unrealistically high, far beyond the range of observed catches. CAFSAC considers that these results are unreliable.

## 13.4 Forecast

CAFSAC is concerned that recruitment has been poor since the year-classes of the early 1970s. If the stock were to experience good recruitment in the near future, it would take about 10 years before it would to be available to the fishery because of the relatively slow growth rate of redfish. There is no analysis available at present to determine whether the current TAC of 35,000 t is an appropriate target level. TACs have not limited the fishery in recent years but if the TAC were reached, catches of 35,000 t, if maintained for a few years, could be detrimental given the poor recruitment to the fishery after the early 1970s. TACs about equal to the catches during the 1980s, that is 20,000 t, would be more prudent for 1991-1993.

## 14. REDFISH IN DIVISION 3O

### 14.1. Description of the Fishery

Over the history of this fishery, nominal catches have ranged between 5,000 and 22,000 t. Catches in 1986, 1987 and 1988 were above 10,000 t but there appeared to be a decline to 4,600 t in 1989 probably because of incomplete statistics for some countries. Canadian catches from this stock have traditionally been low, and totalled 75 t in 1989.

Beyond depths of about 500 meters, the bottom in this division is largely unfishable so the sizes of fish taken are generally smaller than those landed from other areas. This limits the Canadian fleet since it is not economical to process these small fish which are generally less than 25 cm. Other countries do take small fish from the area.

Recent catches and TACs ('000 t) are as follows (Fig. 14.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 20 | 20 | 20 | 20 | 14 | 14 | 14 |
| Nominal catch | 10 | 8 | 10 | 13 | 10 | 4 | |

[1]Catches are preliminary

### 14.2. Assessment and Forecast

The only new information available for this stock was an additional point in the catch rate series. As was the case in the past, the information is not adequate for the calculation of a reference catch. The long-term average catch of about 13,000 t has not resulted in any trend in catch rates over time, possibly suggesting that higher catches are possible. CAFSAC reiterates, however, that the impact of higher catches may require a number of years to detect. The current TAC of 14,000 t should be considered precautionary for 1991-1993, and it should not be changed until the impact of sustained catches nearer to the current TAC have been evaluated.

## 15. REDFISH IN DIVISION 3P

### 15.1. Description of the Fishery

Nominal catches from Division 3P have ranged between 3,600 t in 1985 and 37,000 t in 1970. The largest catches were made in Subdivision 3Ps during the mid-1960s to late-1970s. Catches from Subdivision 3Ps have been below 4,000 t since 1982. In 1989, almost 75% of the total catch of 9,992 t was taken in Subdivision 3Pn. Catches by Maritime vessels increased markedly beginning in 1986, and most of the increased effort was concentrated in Subdivision 3Pn. During the 1980s, Newfoundland vessels took approximately equal amounts from both subdivisions. Landings from Subdivision 3Pn ranged between 2,000-4,000 t over the history of the fishery but increased in 1988 and 1989 because of increased effort in the area during the first half of the year. Landings from Subdivision 3Ps are usually spread more evenly throughout the year. In both subdivisions, most of the catch has usually been taken by bottom trawls, although substantial amounts were caught in Subdivision 3Ps using gillnets and longlines. In recent years, most of the catch from Subdivision 3Pn has been taken with midwater trawls.

Nominal catches and TACs ('000 t) in recent years are as follows (Fig. 15.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 18 | 18 | 18 | 18 | 15 | 15 | 10 |
| Nominal catch | 4 | 4 | 7 | 7 | 9 | 10 | - |

[1]Catches are preliminary

In 1989, fish aged 9 to 14 dominated the catches but the presence of the older, large year-classes of the early 1970s could still be detected.

## 15.2. Abundance Indices

*Commercial catch rates*

In 1989, CAFSAC concluded that since redfish in Division 3P possibly did not represent a 'stock', the use of a commercial catch rate as an index of abundance was inappropriate. Because the issue of the definition of a redfish 'stock' in the 3P, 4RST, 4V area has not been resolved, using catch rates as an index of stock size is still inappropriate.

*Research vessel survey data*

Stratified random survey data from Division 3P in February-March for the period 1980-1990 were examined using a multiplicative model to estimate mean values per standard tow for missing strata. Overall, the adjusted results suggest an increase in biomass from the early 1980s to the present. This may indicate a general increase in stock size, a trend toward more Gulf redfish moving into the area in winter in recent years, or a gradual change in the distribution of redfish in the water column at the time of the survey.

Results of these surveys (Feb.-March) and those conducted in January in 3Pn4RST indicate an overwintering concentration in the 3Pn-southern 4R area. The recent increased effort in Subdivision 3Pn in the first half of the year is mainly directed on this aggregation, but the relative contribution of redfish from different areas is unknown. If these increased catches are of Division 4RST fish, then future assessments should take this into consideration. It was also observed that the winter surveys do not cover Subdivision 4Vn, so the possible extension of the concentration into this area is unknown.

Results from acoustic surveys conducted in Division 3P in the summer of 1988 and in 3P4V in 1989 confirm previous evidence, from trawling surveys, that redfish are distributed in a continuous fashion across the entire channel area of 3P4V. Therefore the present separation of stocks along the 3P4V line is inappropriate and should be discontinued. The affiliation between these fish, and those in the Gulf is still unknown, and acoustic survey coverage is insufficient at present to explore this. Estimates from the two acoustic surveys are consistent, suggesting approximately 225,000 t in Division 3P and about 350,000 t in 3P plus channel part of 4V.

## 15.3. Assessment and Forecast

Because of the remaining uncertainties about stock structure and the mixing of fish from different areas, CAFSAC is unable to provide an assessment and associated reference catch. However, CAFSAC believes that unlimited fishing in 3P/4V, an area of mixing, should be prevented. CAFSAC suggests an upper catch limit of 15,000 t in 3P to allow flexibility in the exploitation of what appears to be a single body of fish in divisions 3P and 4V. CAFSAC hopes to be able to suggest a new management unit for redfish in 3P-4V for the 1992 fishing year.

## 16. REDFISH IN DIVISIONS 4R, 4S AND 4T

### 16.1. Description of the Fishery

The rapid increases in the catches from less than 20,000 t in the 1950s to 130,000 t in 1973 was almost entirely the result of increased Canadian effort. TACs were introduced in 1976, as the very strong year-classes of the late 1950s had passed through the fishery. The first TAC was set at 30,000 t, and the level was subsequently reduced to 16,000 t within two years. Catches have been less than the TAC except in 1976 and 1981. In recent years some fleet components have caught their allocation.

Recent TACs and catches are listed below ('000 t) (Fig. 16.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 50.6 | 50.6 | 55.6 | 50 | 56 | 57 | 57 |
| Nominal catch | 35 | 28 | 34 | 34 | 36 | 43 | |

[1]Catches are preliminary

### 16.2. Abundance Indices

Catch and effort data for 1959-89 were standardized using a multiplicative model, taking into account potential differences in the fishing power of midwater trawls used before 1986 and those used since that date. The resulting catch rate series (Fig. 16.2) was similar to that calculated previously and continued to show two distinct peaks in 1967-68 and 1980-81, with the latter one being followed by an overall decline in catch rate through to 1987. The 1988 value represented an increase of 40% over the 1987 value and catch rates have continued to increase in 1989.

Biomass estimates of redfish from the summer research surveys in the Gulf of St. Lawrence appear to be relatively constant (Fig. 16.3). The length frequencies from the 1989 survey (Fig. 16.4) shows clearly the dominance of 27-28 cm redfish of the 1978-1980 year-classes. The size distribution is similar in commercial catches.

### 16.3. Assessment

The large number of ages in the population and the low fishing mortality in recent years renders sequential population analysis inappropriate. There are, however, adequate catch and effort data to utilize a general production model. The Gulf redfish stock is however not in a steady state, having been abundant in the mid-1960s, heavily fished and severely reduced in the mid-1970s, and now rebuilding. For that reason, a non-equilibrium version of the general production model was utilized in 1989. The results are not sensitive to the addition of one year's data and the conclusions reached in 1989 still apply.

The 4RST redfish stock is in good condition. It has been possible to follow since 1984, the year-classes that are presently contributing most to the fishery. Catch rates have increased in 1989 and are expected to remain high for the next few years.

### 16.4. Forecast

CAFSAC believes that the current 57,000 t TAC would be appropriate for 1991. CAFSAC plans to review the stock status of 4RST redfish in detail in 1991 and advice for a multi-year management plan will then be provided.

## 17. REDFISH IN DIVISIONS 4V, 4W AND 4X

### 17.1. Description of the Fishery

Catches ranged between 20,000 t and 40,000 t through the 1960s, then rose to a peak of 62,000 t in 1971. Thereafter they fell rapidly until 1976 (18,000 t) and since then have varied between 10,000 t and 24,000 t. The USA, which took catches of 30,000 t annually in the 1950s, and the USSR (from 1960) were the major participants until about 1975. Canadian catches have varied between 3,000 t and 30,000 t.

The TAC was initially set at 40,000 t in 1974, but was reduced to 20,000 t for 1976. It was increased to 30,000 t for 1980 on the basis of estimates of improved stock size and the demonstration that older, larger redfish occurred in waters deeper than those being fished at the time.

Recent catches (predominantly Canadian) and TACs ('000 t) are (Fig 17.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Nominal catch | 10 | 14 | 13 | 24 | 18 | 17 | |

[1]Catches are preliminary

In 1989, 57% of the TAC was caught, with Canada accounting for 99% of a provisional total of 17,041 t. This total represents a decrease of 3% over 1987 landings. As in recent years, Japan was allocated 1,500 t, of which a total of 122 t was caught.

In the recent past, Canadian landings have come primarily from bottom trawlers, however, midwater trawl catches constituted a significant proportion of total landings between 1972 and 1979. This gear component was not active in the fishery between 1980 and 1985, but it constituted a total of approximately 5,500 t in 1987. The midwater trawl catch in 1988 and 1989 was 4,235 t and 7,078 t.

### 17.2. Assessment and Forecast

The available information for this stock is not adequate for annual adjustment of the reference catch. Thus, this year's review was limited to examination of catch levels. A review for this stock in 1987 resulted in a recommended reference catch of 30,000 t. This catch was based on an exploitation rate of 15% of the trawlable biomass, estimated from surveys. Recent information suggests that a single body of redfish inhabit the 4V-3P area. CAFSAC hopes to be able to suggest a new management unit for redfish in 3P-4V for the 1992 fishing year.

## 18. AMERICAN PLAICE IN SUBAREA 2 AND DIVISION 3K

### 18.1. Description of the Fishery

The largest nominal catch reported for this stock was almost 13,000 t in 1970. From 1971 to 1981, catches averaged about 5,500 t, but have been much lower since 1981, exceeding 1,900 t only in 1986 and 1989. In 1987 and 1988, the catch was around 1,000 t, with gillnets in Division 3K taking the majority of the catch in each year. From 1976 to 1988 catches from Subarea 2 from this stock were less than 700 t per year. However, in 1989, Canadian offshore trawlers caught approximately 3,200 t of American plaice in Division 2J, resulting in an increase of the total catch to 4,187 t, the highest since 1981. The Canadian catches in Division 2J were taken mainly in October and November and were

initially in the directed American plaice fishery but later as a by-catch in the cod-directed fishery. This fishery is likely to continue, given the recent quota reductions in the American plaice stock in Division 3LNO. The inshore catch, which is almost exclusively from Division 3K, has fluctuated between 500 and 1,000 t in recent years.

In years when offshore catches were negligible, the peak landings have been in the summer months, primarily from gillnets, but when the offshore catch was substantial, for example in 1977, 1980-81, and 1986 peak catches have occurred in the February to April period. However, as noted previously, the 1989 offshore catch was taken primarily in the fourth quarter.

Recent TACs and nominal catches ('000 t) are as follows (Fig. 18.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Nominal catch | 1 | 1 | 3 | 1 | 1 | 4 | |

[1]Catches are preliminary

As in previous years, the commercial catch in 1988 and 1989 consisted mainly of fish ages 9-12. The mean weights at age show moderate fluctuation between years, which would be expected given the changes in timing of the fishery from year to year. Comparable data are not available for all years prior to 1984, because sampling was sometimes not available for portions of the catch in years where the total catch was low.

## 18.2. Abundance Indices

*Commercial catch rates*

Catch per unit of effort data are available from Canadian offshore trawlers for the period 1976-89. However, in four of the last six years, the directed offshore catch of American plaice from this stock has been less than 25 t. Therefore, no index of abundance can be obtained from the commercial catch per unit of effort data. Nevertheless, in years when a substantial directed fishery has taken place, for example 1981, 1986, 1989, the catch rates obtained by the offshore fleet are quite good relative to the adjacent Grand Bank stock of American plaice, although the directed fishery is usually only for a period of one month or so.

*Research vessel survey data*

Research vessel surveys were conducted in Division 2G in 1978-79, 1981, and 1987-88, in Division 2H in 1978-79, 1981, and 1986-88, in Division 2J from 1977 to 1989, and Division 3K from 1978 to 1989. In Division 2G, the biomass has not exceeded 3,900 t, while in Division 2H, the biomass has ranged between 4,000 t and 18,000 t. In Division 2J, the biomass declined steadily from about 90,000 t in 1982-83 to 23,000 t in 1987 and then increased to 30,000-33,000 t in 1988-89. In Division 3K the biomass fluctuated between 26,000 t and 43,000 t from 1979 to 1986, before declining to 17,000-18,000 t in 1988-89. In both divisions 2J and 3K, fish from the year-classes of the early 1980s dominated the recent surveys. The decline in biomass in Division 2J was of particular interest in this stock because it occurred in the absence of any significant commercial fishery over the same period. Work ongoing for the adjacent Grand Bank stock directed at the effects of temperature on the distribution and abundance of American plaice may be useful in explaining this decline in Division 2J.

### 18.3. Assessment and Forecast

Although the surveys indicate that the stock size was lower in 1989 than in the early 1980s, it appears that the biomass has stabilized in 1987-89, with an increase in Division 2J countered by a decrease in Division 3K. The total stock biomass (Subarea 2 + Division 3K) in 1988 and 1989, as measured by the surveys, was in the range of 50-55,000 t. With an exploitation rate of 20% approximating the $F_{0.1}$, this suggests that the current TAC of 10,000 t be continued in 1991. Given the recent stability in the biomass, this figure is also appropriate for 1992 and possibly 1993.

In 1988 and 1989, CAFSAC advised that consideration be given to splitting the TAC evenly between Subarea 2 and Division 3K, even though recent catches have been well below the TAC. This was based on the 1987 survey which indicated that the biomass in Division 2J had declined to about the level observed in Division 3K, and also as a result of concerns that over 80% of the landings came from Division 3K. However, the 1988-89 surveys show the biomass in Division 2J to be approximately 1.8 times higher than that in Division 3K, which is closer to the long-term average from the 1978-89 surveys. In addition, over 75% of the catch from the stock in 1989 came from Division 2J, largely a result of the offshore catches in the fourth quarter. However CAFSAC is still concerned that American plaice in Division 3K could be more easily overexploited and therefore advises that no more than 50% of the TAC should be harvested in that division.

## 19. AMERICAN PLAICE IN SUBDIVISION 3Ps

### 19.1. Description of the Fishery

Catches from this stock were highest from 1968 to 1973, exceeding 12,000 t on three occasions in this period. Catches by foreign vessels peaked at about 8,800 t in 1968, due mainly to the USSR catch, and have not exceeded 670 t since 1973. Catches by France have ranged from 200 to 665 t in recent years.

The Canadian inshore catch in 1987 (2,000 t) was substantially higher than in most other years from 1972 onward, due to the increase in the gillnet catch. However, the inshore catch declined in 1988-89 to about the level reported in 1986 (1,300 t). After a decline in the early 1980s, the catch by Canadian offshore trawlers increased in 1984-87, with most of the catch (70-90%) being taken in the first quarter. In 1988-89, the catch by this fleet declined slightly and was spread more evenly over the entire year. Overall, the total catch in 1988 was down about 800 t from the 1986-87 level, and the 1989 catch was down a further 800 t from the 1988 value, to about 3,600 t.

Recent nominal catches and TACs ('000 t) are as follows (Fig. 19.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 5 | 5 | 5 | 5 | 5 | 5 | 4 |
| Nominal catch | 3 | 4 | 5 | 5 | 4 | 4 | |

[1]Catches are preliminary

The catch at age and mean weights at age for this stock are based on sampling from the Canadian fishery, because no sampling data are available for the French catches. In 1989, the 1978 and 1979 year-classes were predominant in the catch at age, as was the case in the 1988 fishery. The mean weights at age in 1989 were similar to those observed in 1988, and no trends are apparent in recent years.

## 19.2. Abundance Indices

*Commercial catch rates*

A multiplicative analysis of commercial catch rates of American plaice for the Canadian offshore trawler fleet in Subdivision 3Ps from 1974 to 1989 was conducted. The catch per unit of effort series shows relative stability from 1974 to 1980, an increase from 1980 to 1983, followed by very large increases in 1984 and 1985. In 1987 and 1988, the catch per unit of effort declined to about the same level as in 1983, followed by a further decline of about 13% in 1989. However, the 1989 value is still about 14% higher than the mean catch rate from 1974 to 1980. The magnitude of the increase from 1983 to 1984, then 1985, and the subsequent 40% decline to 1986 suggest that the 1985 and possibly the 1984 points are anomalous.

*Research vessel survey data*

Stratified random surveys have been conducted by Canada in Subdivision 3Ps in each year from 1972 to 1990. Even with the values for the missing strata filled by a multiplicative model, the biomass estimates are highly variable between years with estimates from consecutive surveys often changing by more than half or double. Although the biomass was relatively stable from 1986 to 1988 at around 30,000 t, the value from the 1989 survey was substantially lower at 17,000 t, followed by a further decline to only 6,800 t in 1990. The 1980-82 year-classes were dominant in the 1989 survey, however, the age by age estimates from the 1990 survey are not yet available.

## 19.3. Assessment and Forecast

In the 1989 assessment of this stock, it was noted that the stock size was relatively stable from 1974 to 1988 but that the "the relationships obtained in the calibrations of ADAPT were poor and they did not give reliable estimates of stock size on a yearly basis". Therefore, no attempts were made at this time at using ADAPT to determine stock size.

The catch per unit of effort data and survey indices presented in this assessment continue to show a declining stock size. However, the catch per unit of effort for 1989 was still above that observed from 1974 to 1980, when catches averaged around 4,400 t, and fishing mortalities were between 0.3 and 0.4 in most years. Although the low biomass estimate from the 1990 survey is a cause for concern, this abundance index has been characterized by large variability in biomass between years, for example 1975-77, 1979-80, and 1983-86. Despite signs of decreased abundance, CAFSAC is not sufficiently confident in the assessment to recommend a change in the current TAC and suggests that 4,000 t be used for 1991-1993.

# 20. AMERICAN PLAICE IN DIVISION 4T

## 20.1. Description of the Fishery

Since 1965, nominal catches have varied from a high of 11,780 t in 1966 to a low of 4,987 t in 1989. A TAC of 10,000 t has been imposed on the fishery since 1977. Annual landings in the 1980s have averaged about 7,450 t. The provisional landings for 1989 is a reduction of more than 1,700 t from 1988.

Recent landings and TACs ('000 t) are listed below and shown in Fig. 20.1:

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Nominal catch | 9.6 | 9.5 | 7.2 | 7.8 | 6.7 | 5.0 | - |

[1]Catches are preliminary

Historically, plaice were taken as by-catch in the southern Gulf of St. Lawrence cod fishery. In recent years, a fishery directed for American plaice has taken roughly half the total landings. The gear composition has changed from mainly longlines from 1937 to 1946 to a mixed fishery of longlines, otter trawl, and Danish seines from 1947 to 1964. Since 1965, the importance of gillnets and seines have increased in the directed fishery and seines are now the dominant gear type. The proportion taken by seines increased from 38% to 46% from 1988 to 1989 while the proportion of fixed gear landings decreased from 20% to 15% in the same time period.

During 1988 and 1989, the mobile gear and fixed gear landings were substantially less than the allocations, but restrictions during 1989 in the cod fishery in Division 4T may have impacted on the fishing patterns for American plaice.

*Catch and weight at age*

The landings at age from 1976 to 1989 were re-calculated using length frequencies for each sex separately . Semi-annual age-length keys were used from 1984 through 1989. Because a large percentage of the catch is discarded at sea, the true catch is unknown. Estimates of the discards at age were obtained using data from the research survey series and mesh selectivity ogives. Although the method appeared to track overall discarding rates recorded in recent field observations the accuracy of estimates at each age was deemed insufficient to conduct an analytical stock assessment using sequential population analysis.

## 20.2. Abundance Indices

*Commercial catch rates*

Catch per unit of effort estimates for either the plaice directed or the by-catch fisheries were deemed to be unreliable indices of stock abundance, because of the number of changes in fishing practices over the years.

*Research vessel survey data*

The mean numbers per tow from the groundfish research surveys were low at the beginning of the 1970s, have climbed steadily to a peak in 1977, and declined to 1984. The total mean number per tow in 1989 was the lowest in the series. There has been a period of relative stability at a low level since 1984 (Fig. 20.2).

*Discarding at sea*

Several field studies dating from the late 1950s to 1984 have recorded discarding rates of between 46 and 85% of the catch by number. The most recent empirical study undertaken shortly after the change to the present 130 mm mesh size limit suggested a rate of 62% by number. Estimates of discards calculated from survey results as described above ranged from 46 to 85% of the catch.

## 20.3. Assessment and Forecast

*Fishing mortality and stock abundance*

Total mortality was estimated from research vessel numbers at age per tow from 1971 to 1988. While mortality estimates were variable from year to year there was generally higher total mortality in the 1980s than in the 1970s. Average fully-recruited fishing mortality estimated from 1984-89, was near 0.28. The 10+ fishable biomass was 26,000 t in 1988 and 22,000 t in 1989.

However, given that discarding of small plaice by mobile gear is a severe problem in this fishery, CAFSAC will attempt to quantify the gains that could be achieved if the discards were reduced. Until such time, the TAC could be kept at its present value of 10,000 t because CAFSAC believes that reducing the TAC with present enforcement and fishing practices may only result in greater discarding. The best way to enhance conservation for 4T plaice would be to reduce the catch and discarding of small plaice.

# 21. WITCH IN DIVISIONS 2J, 3K, AND 3L

## 21.1. Description of the Fishery

Catches increased from 1,000 t in 1963 to 24,000 t in 1973, subsequently declined to less than 5,000 t and have averaged about 3,500 t annually since 1979. Prior to 1977, Poland, USSR, and Canada took most of the catch. More recently, it is mainly taken by Canada and Poland primarily on spawning concentrations during the winter-spring period in Division 3K although there has been increased activity reported by EEC (Portugal) on the nose of the Grand Bank in Division 3L. The TAC was initially set at 24,000 t in 1974 and was reduced to 17,000 t for the next 7 years. It was then reduced to 8,000 t in 1981 since there was no indication of stock rebuilding despite catches having been lower than the TAC. It was reduced further to 6,000 t in 1987, 5,000 t for 1988 and 1989, and 4,000 t in 1990, largely based upon similar observations. Recent TACs and catches ('000) t are (Fig. 21.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 8 | 8 | 8 | 6 | 5 | 5 | 4 |
| Nominal catch | 5 | 3 | 4 | 4 | 4 | 5 | |

[1]Catches are preliminary

## 21.2. Abundance Indices

There are insufficient commercial effort data to derive a reliable catch rate series, therefore the status of this resource is mainly based upon an evaluation of research vessel survey data. Estimates of biomass from autumn research vessel surveys prior to 1986 indicate that about 80% of the stock biomass occurred in Division 3K, however, for 1986-88, just over half the stock biomass is estimated to have occurred in this division and considerably less than half from 1989 estimates. Biomass estimates from 1981 to 1984 for the three divisions combined averaged about 42,000 t and have declined to about 20,000 t in 1988, and 12,000 t in 1989, the lowest value in the time series. The magnitude of the decline is considered to be too large to be attributed solely to the fishery. The results of the survey in Division 3K suggest that there may have been migration to deeper strata which are not adequately surveyed, thus underestimating the biomass. Strata contiguous to non-sampled deep-water strata have exhibited proportionately more biomass in recent years than in the past. It is known from commercial offshore operations that, in recent years, particularly in 1988 to 1990, large concentrations of prespawning witch flounder have been located in areas of Division 3K during the winter-spring period at

depths in excess of 800 m. A preliminary examination of Canadian commercial catch rate data from the observer program for 1988 and 1989 indicated that the catch rates between the two years were similar as were the estimated area of high density. This would support the suggestion that the magnitude of the decline in stock biomass as determined from research vessel surveys may be overestimated especially when considering the depths of the commercial fishery compared to those covered by surveys. However, concentrations could not be located in these areas by the commercial fishery during the summertime and no information from the commercial fishery was available for the autumn to corroborate the extent of possible migration to deeper water as observed in the Division 3K survey data.

### 21.3. Assessment and Forecast

CAFSAC noted in 1986, that this stock had appeared to have established an equilibrium at a lower biomass level compared to the past. The maximum age appeared stable at about 14 years compared to 26 years in 1976. If the stock were not in equilibrium, it would be expected that the maximum age would change over time. Average catches of 4,000 t were taken during this period of stability. The present analysis also suggests that the age structure since 1985 remained relatively stable; yet, the stock is estimated at less than one-third that of the early 1980s according to research surveys. Given that the magnitude of the decline in stock size may be overestimated and is unlikely to be solely the result of fishing, a further reduction in the current TAC of 4,000 t is not advised at this time. Should a further evaluation of the resource prove the stock decline to be significant, an annual catch of 4,000 t in the short term, nevertheless, would not be harmful and CAFSAC suggests that the 1990 TAC be maintained for 1991-1993.

## 22. WITCH IN SUBDIVISION 3Ps

### 22.1. Description of the Fishery

The catches of witch flounder in Subdivision 3Ps were about 1,000 t annually during the early 1960s. Catches increased to over 4,000 t in 1967-69, then declined slowly to former levels in 1977. During the last ten years, annual catches have been most often less than 1,000 t. The provisional catch for 1989 is 840 t including catch by French vessels.

Recent TACs and catches ('000 t) are as follows (Fig. 22.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Nominal catch | 0.5 | 0.6 | 1.3 | 1.1 | 0.6 | 1 | |

[1]Catches are preliminary

### 22.2. Assessment and Forecast

In 1987 CAFSAC reported that the stock appeared to be in equilibrium with recent catches less than 1,000 t. Not only has the biomass estimated by research surveys from 1976 to 1990 been relatively stable, but the age structure is much younger in recent years than in the past and is not increasing. The maximum age in the research catches was 22 years in 1976 but was only 14 in 1980 and remained stable through 1989. It would be expected that the maximum age would have increased if the stock was increasing. A similar conclusion can be drawn from the age range of the majority of the catch that is, 9-11 year olds in 1976 and 6-8 since 1980. CAFSAC concluded in 1989 that the stock would remain relatively stable with annual catches not exceeding 1,000 t and recent information from research vessel surveys and commercial catch at age continues to support this conclusion. The current TAC could therefore be kept for 1991 to 1993.

## 23. WITCH IN DIVISION 4R AND 4S

### 23.1 Description of the Fishery

Catches have been generally less than 2,000 t except during the period between 1974-1980 when they rose to as high as 5,300 t (1976). A TAC was first established for 1977 at 3,500 t, based on average catch levels. However, because the presence of large, old fish in the population which were being landed in "jellied" condition, the TAC was increased to 5,000 t in 1979. The objective was to exploit the stock heavily in order to reduce the proportion of old fish in the population. Although the abundance of older fish was reduced, catches did not reach the new TAC and, in fact, declined. The TAC was reduced to 3,500 t in 1982. The provisional catch for 1989 is 1,066 t. Ninety percent of the catch was taken in division 4R. Recent nominal catches and TACs ('000 t) are as follows (Fig. 23.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| Nominal catch | 0.7 | 0.8 | 0.5 | 0.8 | 1.1 | 1.1 | |

[1]Catches are preliminary

### 23.2 Assessment and Forecast

The available information for this stock is not adequate for annual adjustment of the reference catch. Thus, this year's review has been limited to examination of catch levels. A review for this stock in 1987 resulted in a recommended reference catch of 3,500 t. This catch is considered the long-term sustainable yield for the stock and the TAC can be set at that level for 1991-1993.

## 24. ATLANTIC HALIBUT IN DIVISIONS 3N, 3O, 4V, 4W, 4X AND SUBDIVISION 3Ps

### 24.1 Description of the Fishery

Since 1964, when reliable statistics for this species were first available, landings have ranged from 1,204 t in 1975 to 4,190 t in 1985. The increase in landings in the mid-1980s is thought to be associated with the introduction of the circle hook to the fixed gear fishery, a more effective means of capturing halibut than the traditional J-hook. Landings in 1989 were 1,840 t, a slight decrease from the 1988 level of 2,050 t. In addition to the fixed gear component, the fishery is exploited by mobile gear. The proportion of total landings taken by the fixed gear sector has been increasing over recent years.

Within the management unit, landings from 4VWX typically comprise the largest proportion of total landings. Landings from 3NO are also significant, although the prosecution of the fixed gear fishery in that area has recently been hindered by cod by-catch regulations. Several management measures have been introduced in 1988 including a 3,200 t precautionary TAC, the establishment of a by-catch fishery only for mobile gear, and a minimum size limit (81cm) for all sectors.

Recent landings and TACs are listed below ('000 t) (Fig. 24.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | - | - | - | - | 3.2 | 3.2 | 3.2 |
| Nominal catch | 3.1 | 3.9 | 3.4 | 2.0 | 2.1 | 1.8 | - |

[1]Catches are preliminary

### 24.2 Assessment and Forecast

Several methods were tried to assess stock size, exploitation rates and potential catches but the data were considered insufficient to use catch curves, general production and yield per recruit models. However there are indications that abundance may be decreasing as suggested by the downward trend in the catch rate. The unchanged average size of halibut taken in the fishery since 1980 and anecdotal reports from fishermen indicating good catch rates in 1990 support the view that the resource is not overexploited. However, at this time, it is not possible to determine the exploitation rate of the resource and CAFSAC suggests that the current precautionary TAC should be kept for 1991-1993.

## 25. ATLANTIC HALIBUT IN DIVISIONS 4R, 4S AND 4T

### 25.1 Description of the Fishery

Landings of Atlantic halibut in the Gulf of St. Lawrence declined from 490 t in 1970 to 90 t in 1982 and have been relatively stable in the 200-250 t range in recent years. Recent TACs and nominal catches ('000 t) are as follows (Fig. 25.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | - | - | - | - | .3 | .3 | .3 |
| Nominal catch | .18 | .16 | .27 | .25 | .25 | .22 | |

[1]Catches are preliminary

### 25.2 Assessment and Forecast

The information for this stock is not adequate for annual adjustment of the reference catch. A review in 1987 resulted in a recommended precautionary TAC of 300 t based approximately on average catch. CAFSAC suggests that this precautionary TAC be kept for 1991-1993.

## 26. GREENLAND HALIBUT IN DIVISIONS 4R, 4S, AND 4T

### 26.1 Description of the Fishery

The fishery for Greenland halibut in Division 4RST is prosecuted mainly by Quebec based gillnets in western Division 4S and 4T and also as a by-catch in the shrimp fishery. Catches have fluctuated since 1970 between 800 t in 1972 and 11,000 t in 1987 following two strong pulses of recruitment. Catches reached a maximum in 1987 due to a combination of strong recruitment and good prices but declined in 1988 to 7,546 t and to 5,121 t in 1989. This decline was apparent in all gear sectors involved in the fishery.

Recent TACs and nominal catches ('000 t) are as follows (Fig. 26.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 5.0 | 5.0 | 5.0 | 8.95 | 10.5 | 10.5 | 10.5 |
| Nominal catch | 2.1 | 2.3 | 6.5 | 11.0 | 7.6 | 5.1 | |

[1]Catches are preliminary

### 26.2 Assessment and Forecast

Catch rates from the commercial fishery and biomass estimates from the surveys suggest that stock size is continuing to decrease. There are preliminary indications, from the summer 1989 survey, of incoming recruitment but it is too early to quantify its possible contribution to future catches. CAFSAC will follow these year-classes and advise when catches may be expected to increase. The current precautionary TAC could be kept for 1991-1993.

## 27. FLATFISH IN DIVISIONS 4V, 4W AND 4X

### 27.1 Description of the Fishery

Four flatfish species (exclusive of the halibuts) are exploited commercially on the Scotian Shelf. Listed in order of decreasing landings in 1989, they include American plaice, witch flounder, yellowtail flounder and winter flounder. Of these, only American plaice, witch flounder and yellowtail flounder are under quota management. For the purposes of quota allocation and monitoring, the three species are combined. The landings of winter flounder typically are comparatively low, although locally significant along the Nova Scotian coast and in the Bay of Fundy.

The annual catch of the three main species has been as high as 54,000 t in 1968, but in only three other instances exceeded 30,000 t. Since 1975, they have been less than 20,000 t. The USSR took the majority of the catch during the period of high landings. Canadian catches increased to 24,000 t in 1968 but since 1970, have been 15,000 t or less. A combined TAC for the three species was set at 32,000 t in 1974, reduced to 28,000 t for 1976 and reduced further to 14,000 t in 1978. The latter reduction was partly related to concerns about declines in the witch and American plaice populations, but was also chosen as a conservation measure that should have allowed rapid increase in the abundance of all three species.

Landings of Scotian-Shelf flatfish under TAC management were 7,644 t in 1989 compared with 7,298 t in 1988, a 5% increase. American plaice landings have increased from 3,425 t in 1988 to 3,854 t in 1989, witch flounder landings have decreased from 2,810 t in 1988 to 2,284 t in 1989, and yellowtail flounder landings increased from 1,063 t in 1988 to 1,504 t in 1989. As has been the case since 1977, landings from 4V accounted for the largest proportion of landings by division for the three species under quota management.

The largest fraction of American plaice and yellowtail flounder landings are taken by stern otter trawl, with longliners and Danish-Scottish seiners also well represented. However, for witch flounder, Danish-Scottish seines account for the largest fraction of landings by gear type.

Recent TACs and nominal catches ('000 t) are listed below (Fig. 27.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Nominal catch | 11 | 8 | 8 | 9 | 7 | 8 | |

[1]Catches are preliminary

### 27.2 Assessment and Forecast

The catch and effort data from the commercial fleet cannot be used to provide an overall catch rate index because an increasing amount of the catch is being taken in fisheries directed for other species. Research surveys have provided inconsistent information on abundance changes for these species,

particularly when attempts are made to follow year-classes through the population from year to year.

CAFSAC notes that this fishery is largely a by-catch fishery. CAFSAC advises that future catches should be regulated, but it cannot provide a quantitative recommendation at this time. While there is no quantitative analysis to support a catch of 14,000 t in 1991, CAFSAC notes that catches between 8,000 t and 10,000 t have been sustained since the early 1980s and TACs of that magnitude could apply for 1991-1993. CAFSAC also notes that work is currently underway to redefine this management unit on a species and stock basis.

## 28. WHITE HAKE IN DIVISION 4T

### 28.1 Description of the Fishery

Landings from this small vessel inshore fishery have ranged from a high of 14,000 t in 1981 to a low of 3,600 t in 1974. In 1982 a precautionary TAC was set at 12,000 t. The 1989 nominal catch was 5,100 t a reversal of the declining trend since 1980.

Recent TACs and nominal catches are as follows ('000 t) (Fig. 28.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 12 | 12 | 12 | 9.4 | 5.5 | 5.5 | 5.5 |
| Nominal catch | 6.6 | 6.0 | 4.9 | 6.2 | 3.9 | 5.1 | |

[1]Catches are preliminary

### 28.2 Assessment and Forecast

In 1989, commercial catch and effort for gillnets were analyzed using a multiplicative model. The results were not considered to represent the abundance of the stock while estimates of abundance from research surveys are highly variable and show no trend. A forecast is not possible at this time. Management measures aimed at protecting juvenile fish should be encouraged.

## 29. ARGENTINE IN DIVISIONS 4V, 4W AND 4X

### 29.1 Description of the Fishery

The argentine fishery, which began in the early 1960s, has been prosecuted primarily by the USSR and Japan. TAC regulation was initiated in 1974 and, from the late 1970s, the fishery has been restricted in season and area by the Small Mesh Gear Line Regulations. In recent years, catches have been taken largely as a by-catch in the silver hake fishery, the provisional 1989 catch being about 100 t. Recent TACs and catches are ('000 t) (Fig. 29.1):

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| TAC | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Nominal catch | .4 | .3 | .2 | .1 | .4 | .1 | |

[1]Catches are preliminary

### 29.2 Assessment and Forecast

The available information for this stock was not adequate for annual adjustment of the advised catch. Thus, this year's review has been limited to examination of catch levels. A review for this stock in 1987 resulted in a

recommended reference catch of 10,000 t. This catch is based on the long-term average yield of $F_{0.1}$ calculated from survey biomass estimates and TACs of that magnitude would be applicable for 1991-1993.

Fig. 1.1. Nominal catches and TACs for cod in Division 2GH.

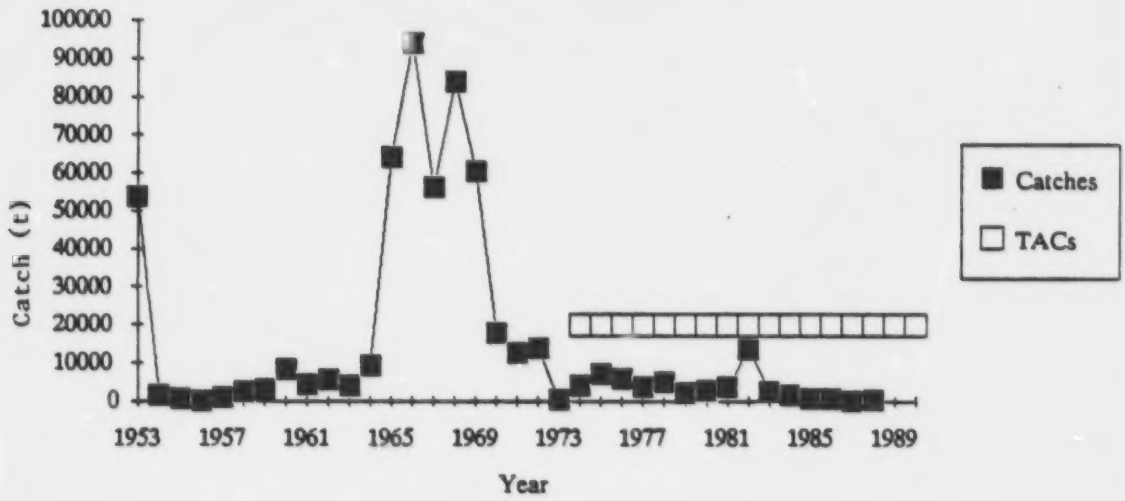


Fig. 2.1. Nominal catch and TACs for 2J3KL cod.

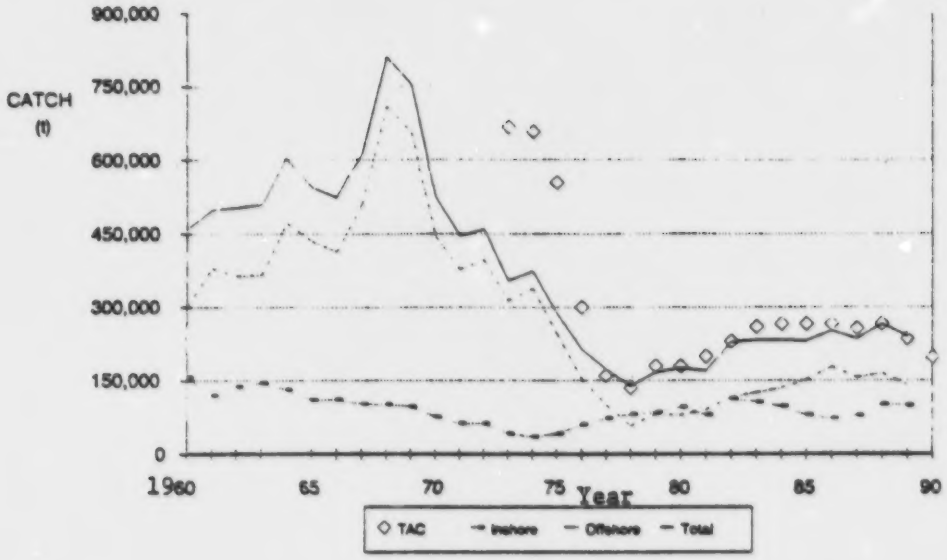



Fig. 2.2. Research vessel biomass estimates for 2J3KL cod.

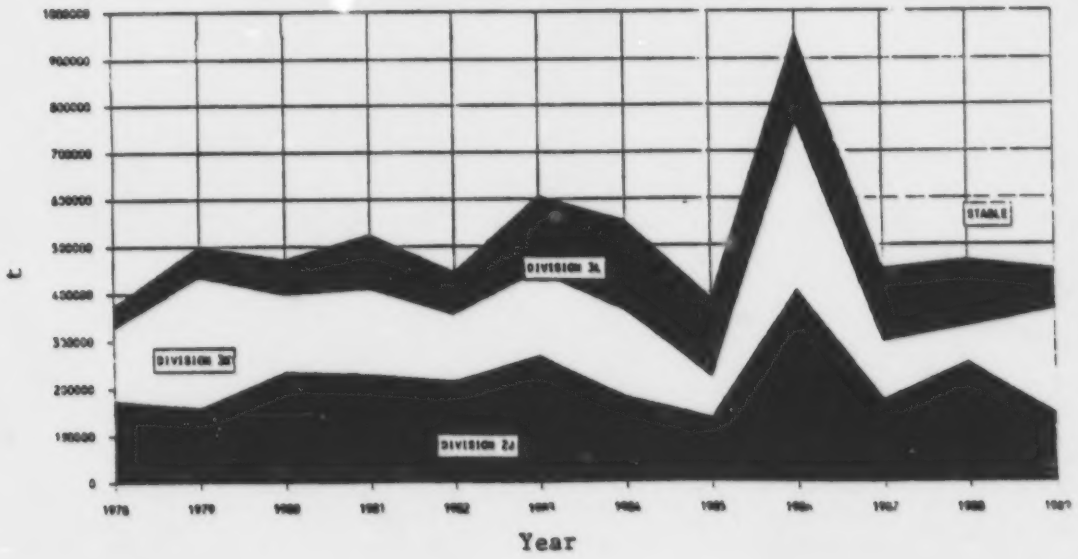


Fig. 2.3. Commercial catch per unit of effort 2J3KL cod.

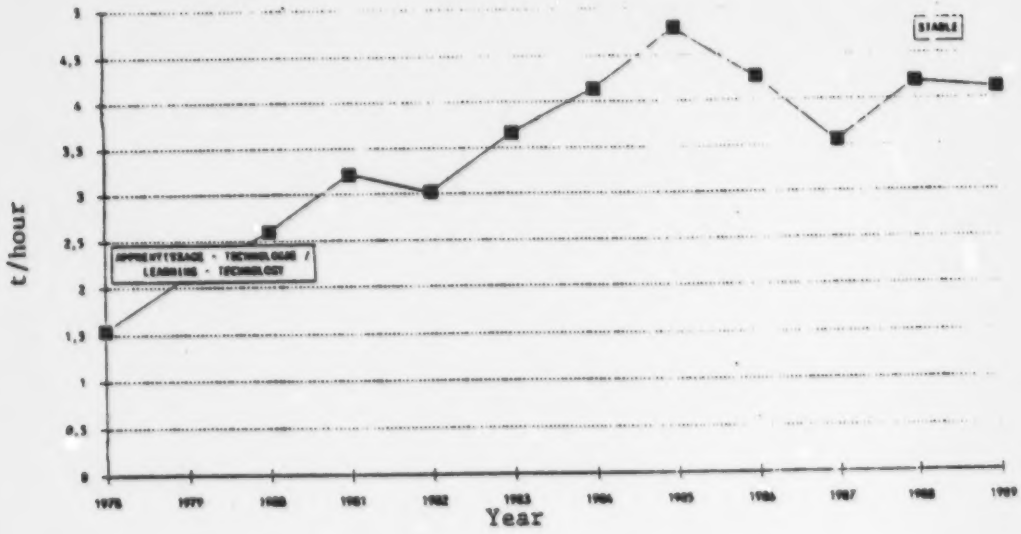



Fig. 2.4. Population biomass (January 1), ages 3+ for cod in Divisions 2J3KL.

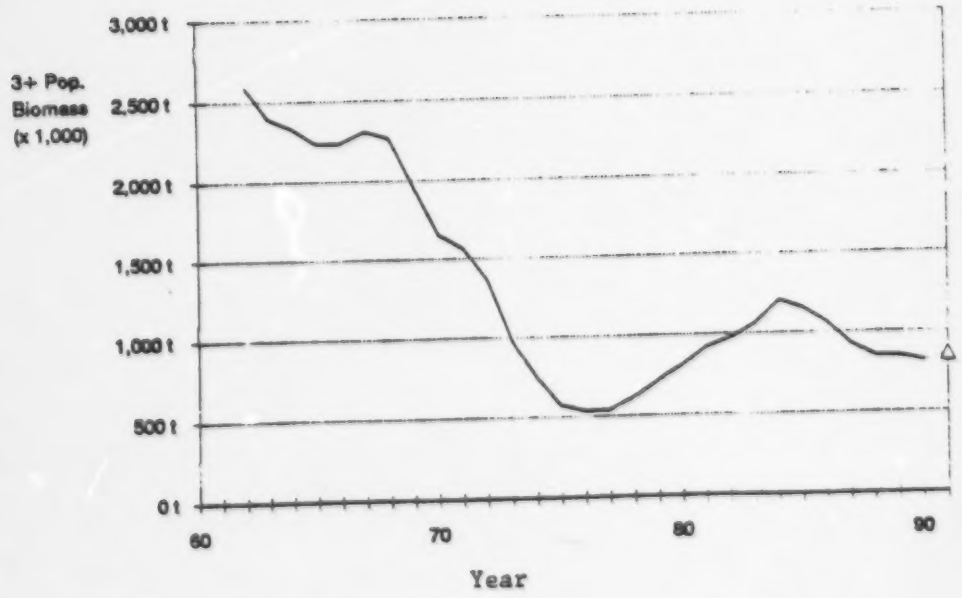


Fig. 2.5. January 1 population numbers (age 3) for cod in Divisions 2J3KL.

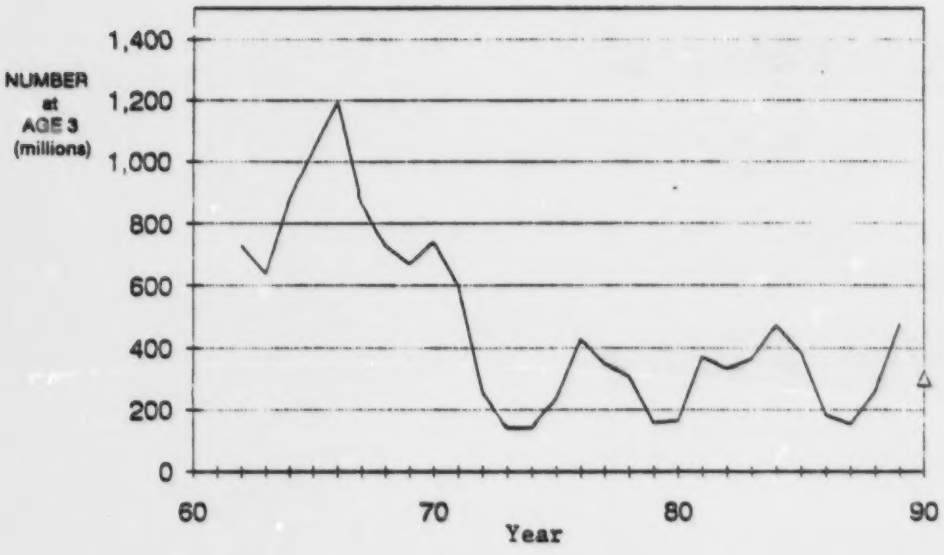



Fig. 2.6. Mean fishing mortality at ages 7-9 (weighted by population numbers) for cod in Divisions 2J3KL.

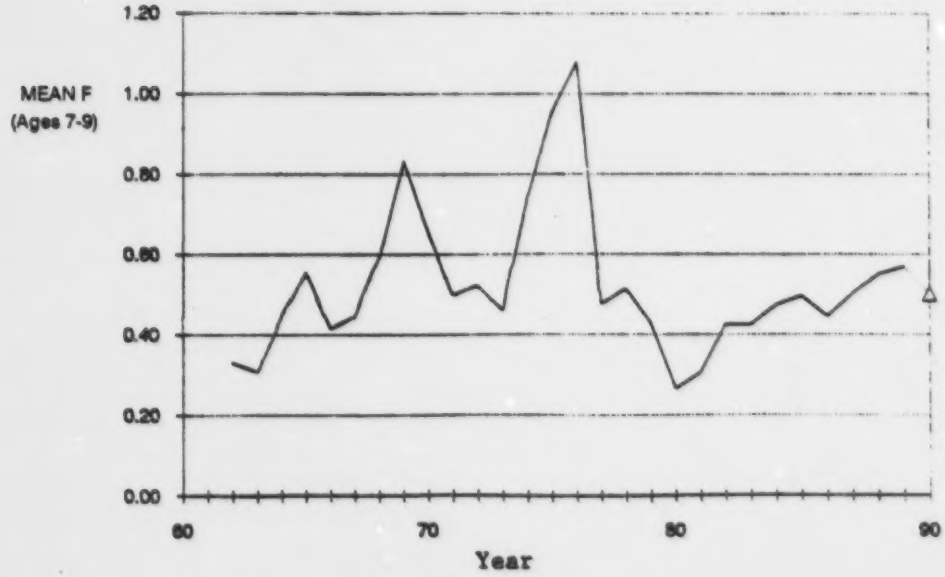


Fig. 2.7. Comparison of 1989 and 1990 assessments for 2J3KL cod.

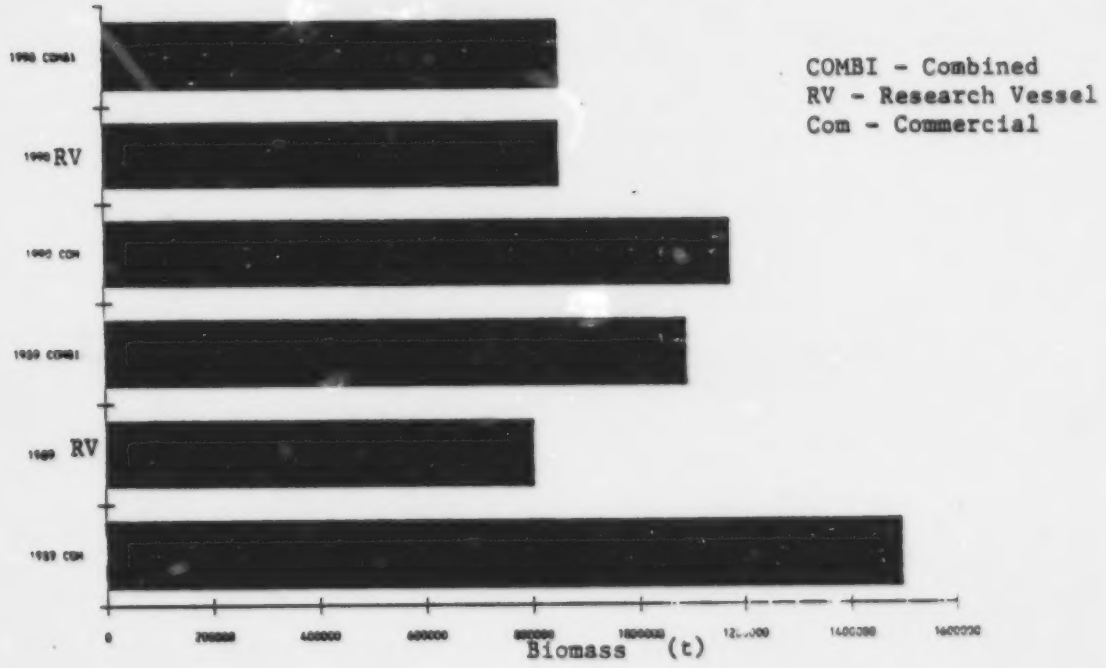


Fig. 3.1. Nominal catch and TACs for 3Pn, 4RS cod

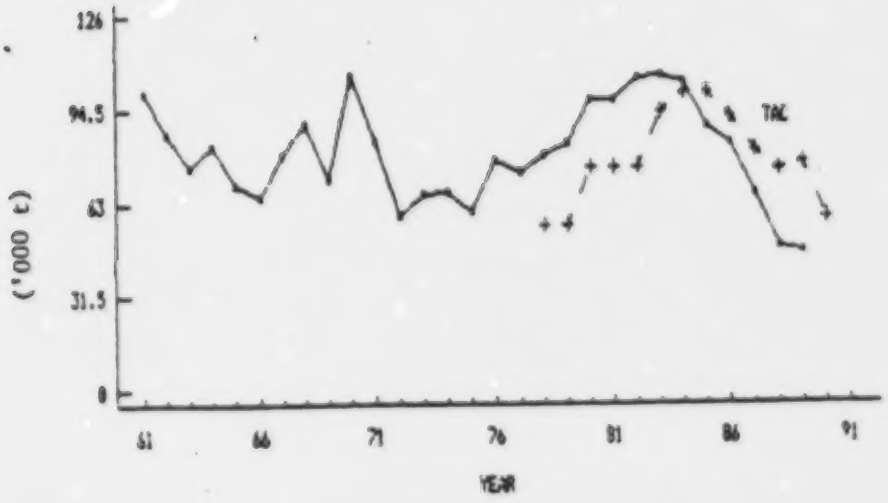



Fig. 3.2. Standardized catch rates for 3Pn, 4RS cod

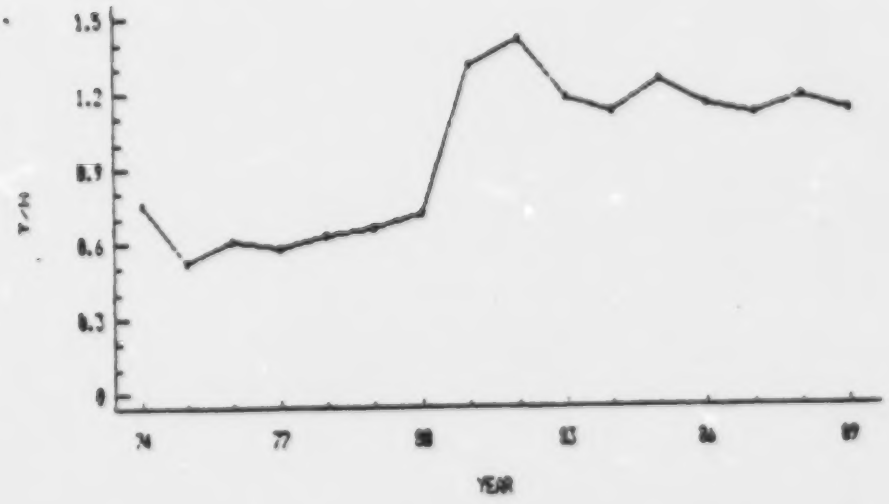


Fig. 3.3. Research survey biomass estimates for 3Pn, 4RS cod

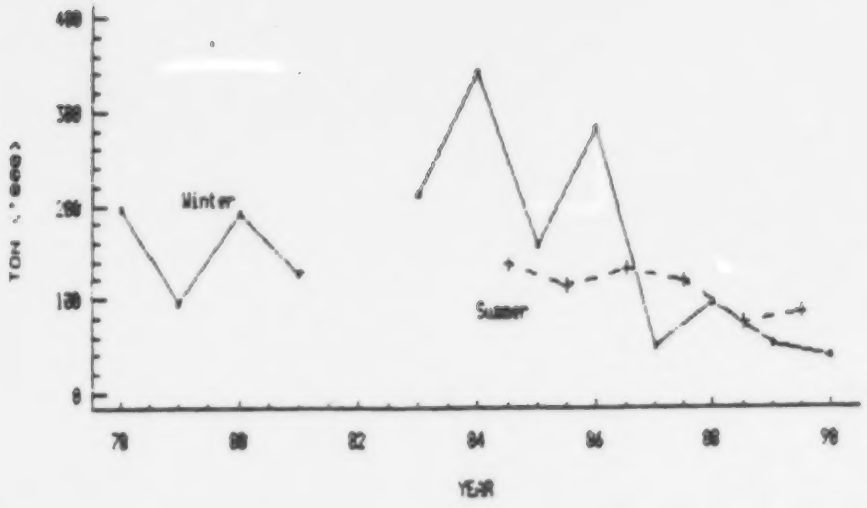


Fig. 4.1. Nominal catch and TACs for 4T-Vn (Jan.-Apr.) cod

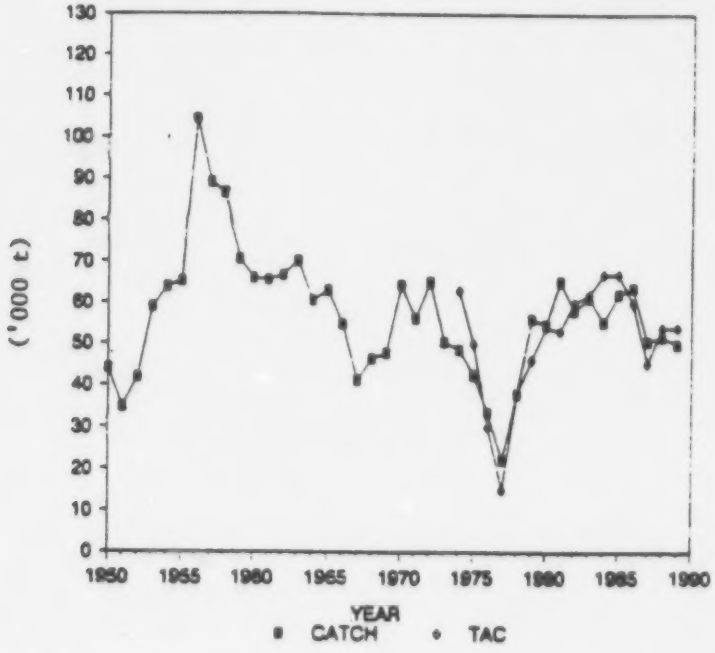



Fig. 4.2. Otter trawl catch rate for 4T-Vn (Jan-Apr) cod

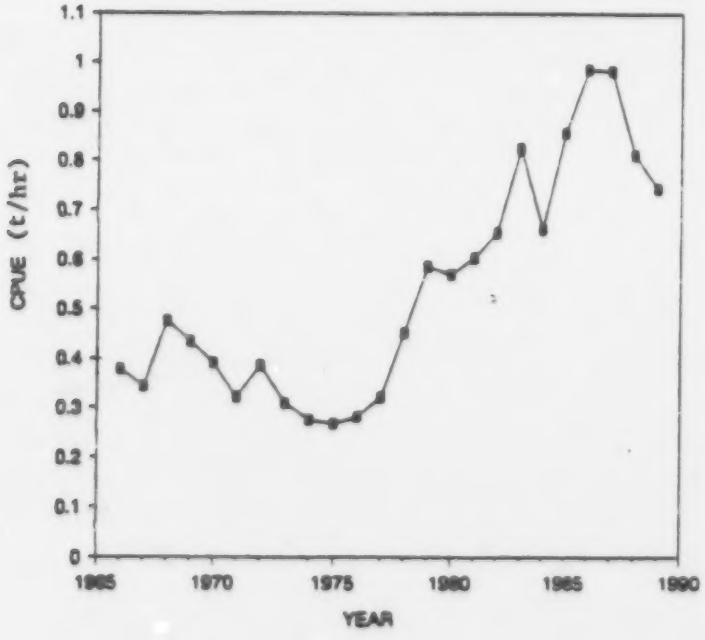


Fig. 4.3. Research vessel 3+ mean numbers per tow for 4T-Vn (Jan-Apr.) cod

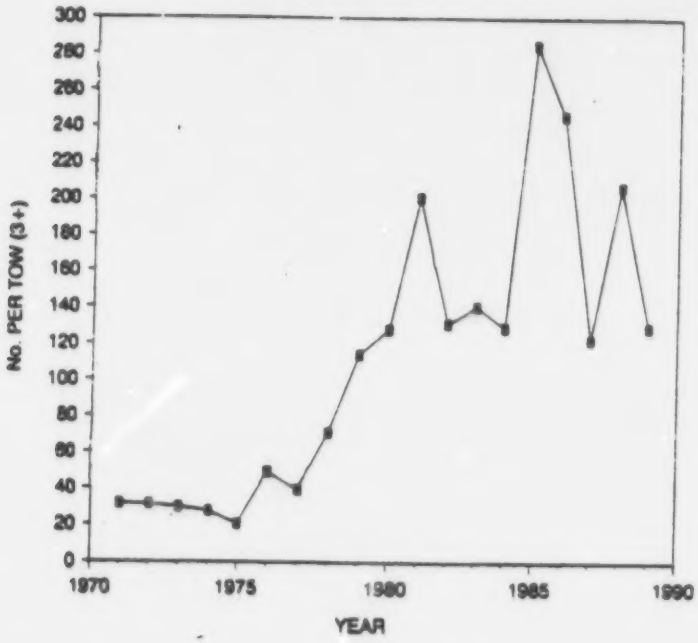



Fig. 4.4. Recrutiment estimates for 4T-Vn (Jan-Apr) cod

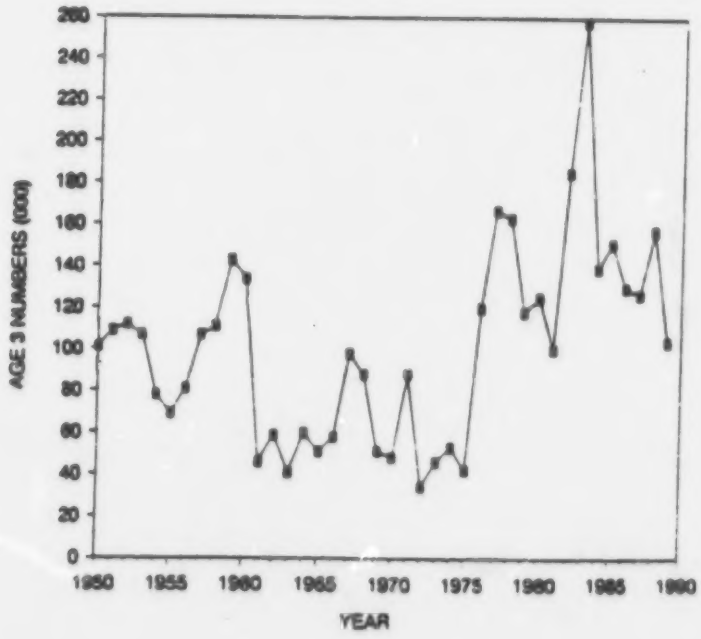


Fig. 4.5. Mean population biomass for 4T-Vn (Jan-Apr) cod

Fig. 4.6. Fully recruited (8+) fishing mortality for 4T-Vn (Jan-Apr) cod

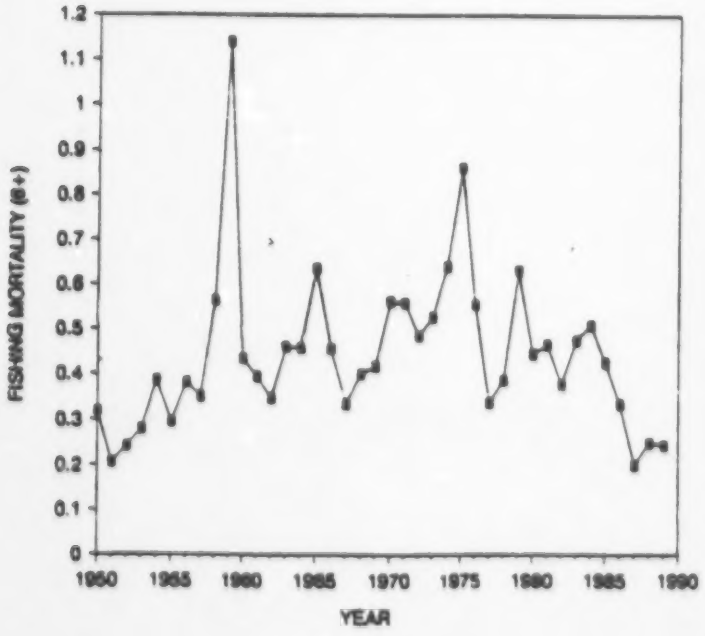


Fig. 4.7. Population numbers for 4T-Vn (Jan-Apr) cod

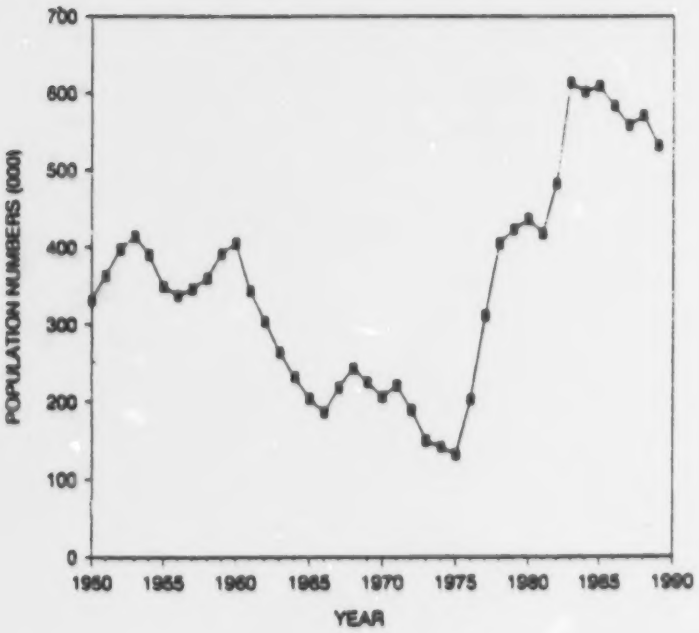


Fig. 5.1. Nominal catch and TACs for 4Vn (May-Dec.) cod

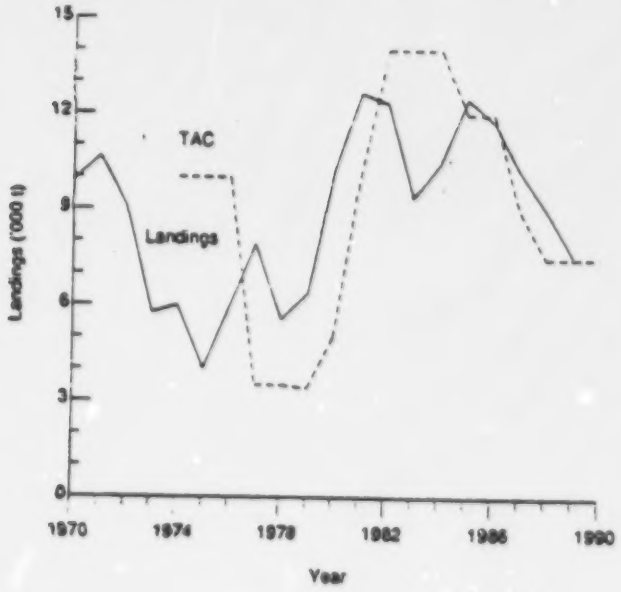



Fig. 5.2. Research vessel abundance indices for 4Vn (May-Dec.) cod

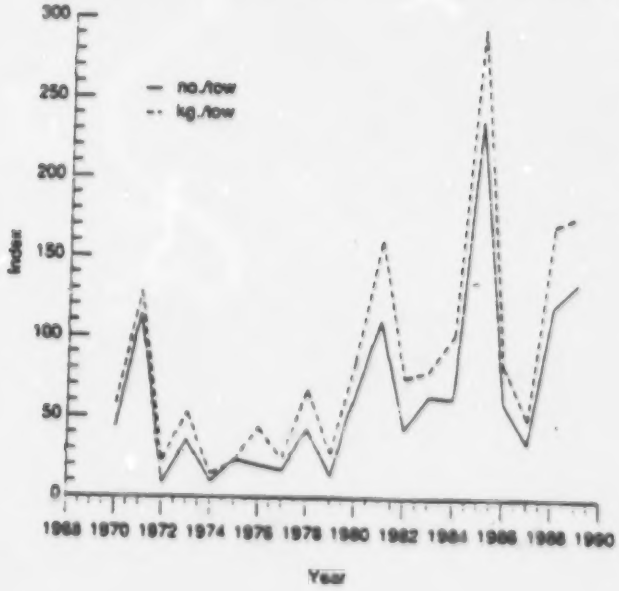


Fig. 6.1. Nominal catch and TACs for 4VsW cod

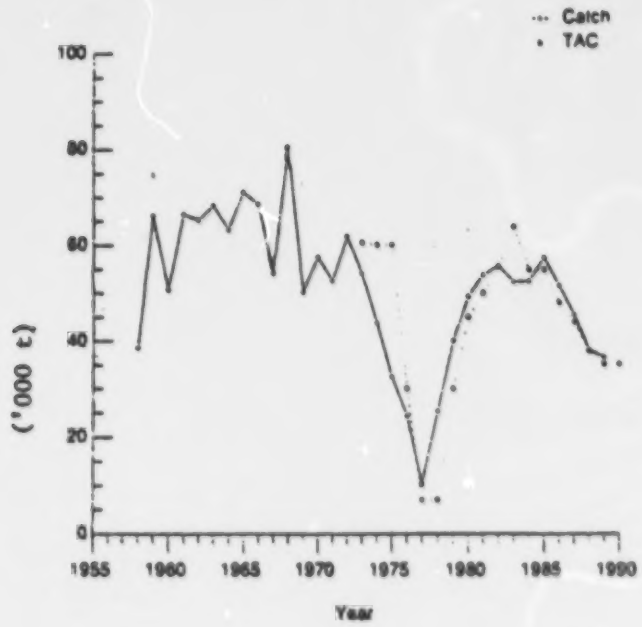



Fig. 6.2. Commercial and International Observer Program (IOP) catch rates for 4VsW cod (standardized)

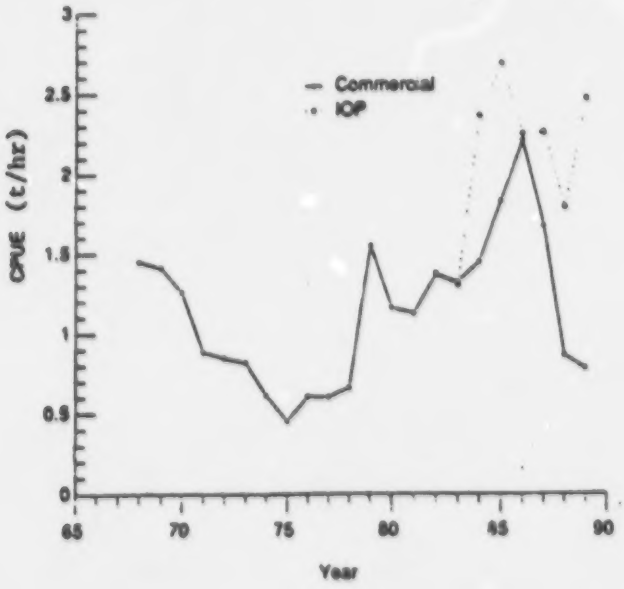
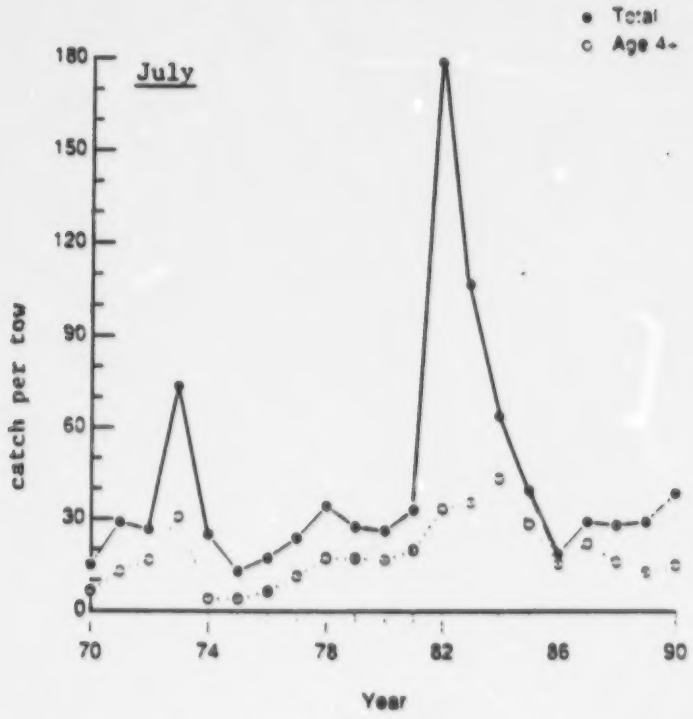


Fig. 6.3. July and March research vessel surveys for 4VsW cod.



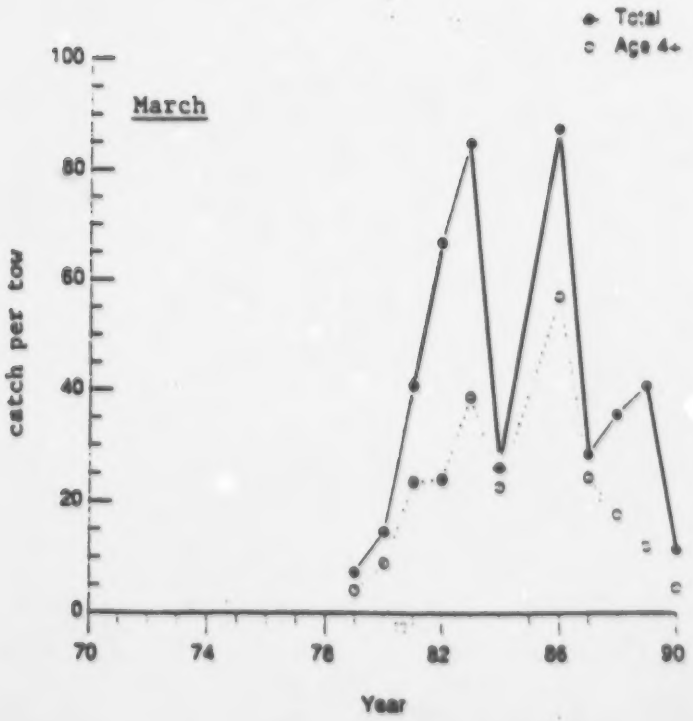



Fig. 6.4. Abundance in numbers and biomass 4VsW cod.

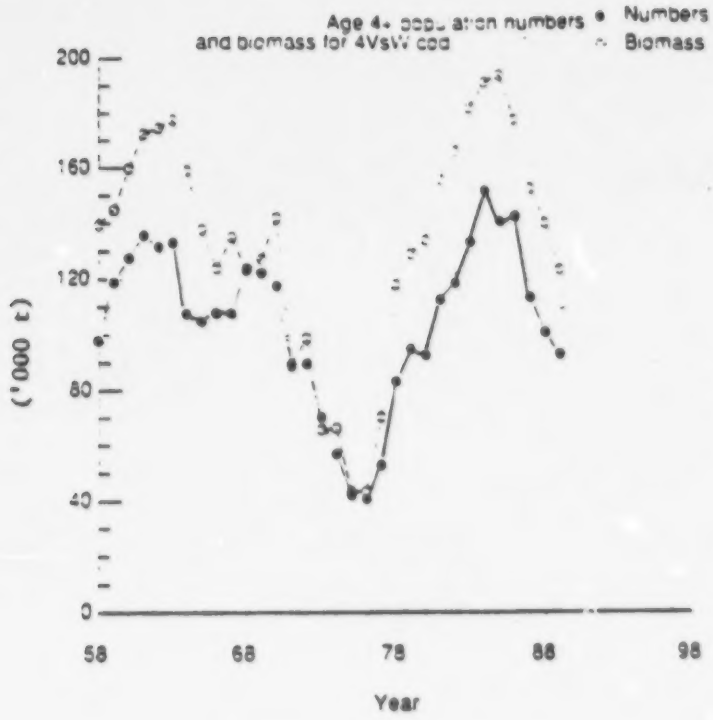



Fig. 6.5. Mean fully recruited fishing mortality (ages 7-9) in 4VsW cod.

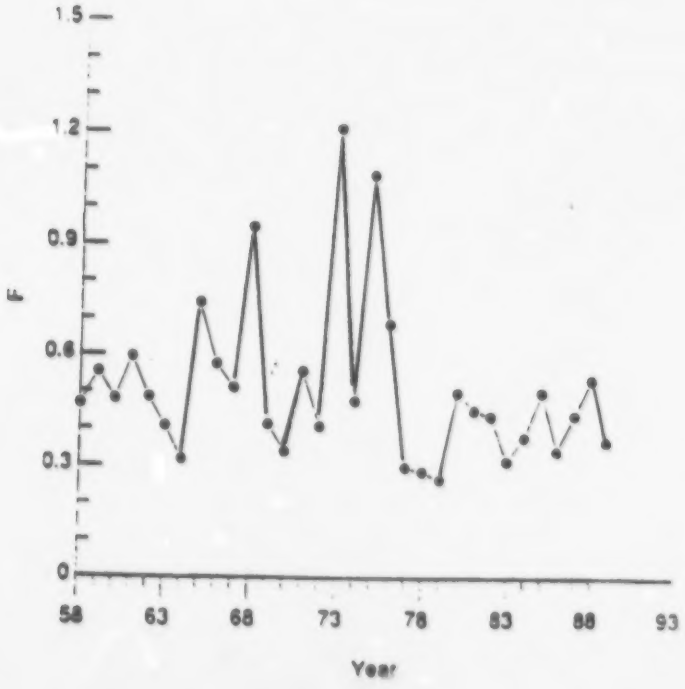


Fig. 6.6. Age 1 recruitment in 4VsW cod.

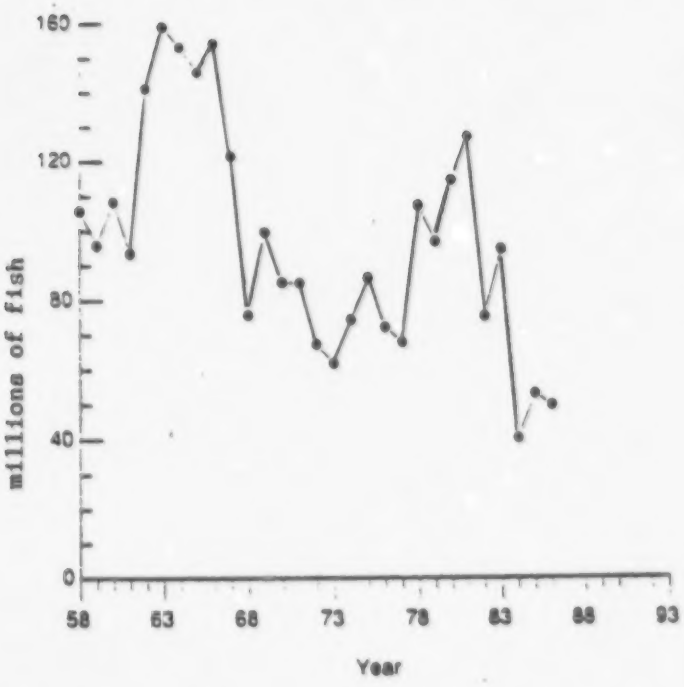


Fig. 7.1. Nominal catch and TACs for 4X cod

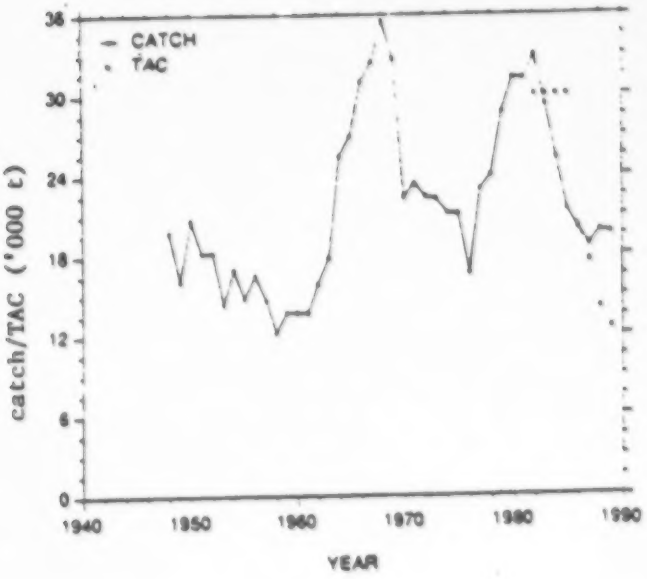



Fig. 7.2. Research vessel and scaled population for ages 3-7 for 4X cod

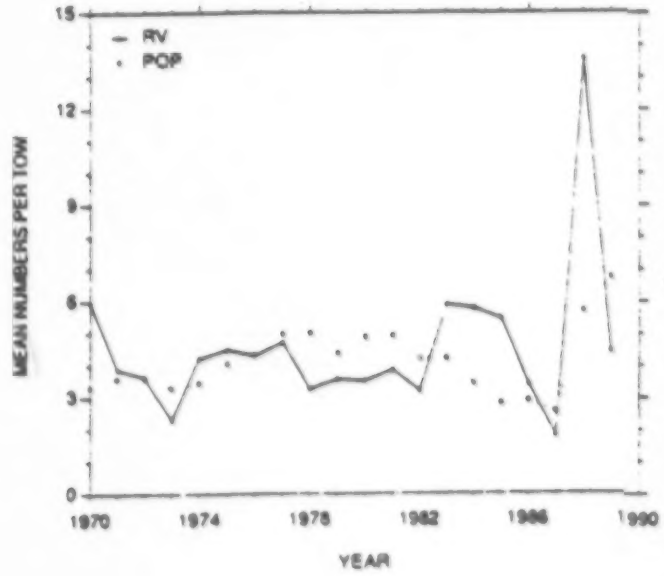


Fig. 7.3. Sequential population analysis fishing mortality (6+) for 4X cod

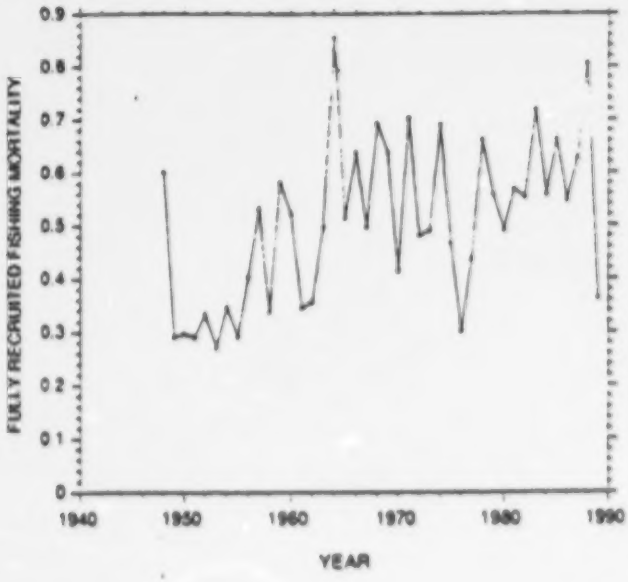



Fig. 7.4. Sequential population analysis population biomass for 4X cod

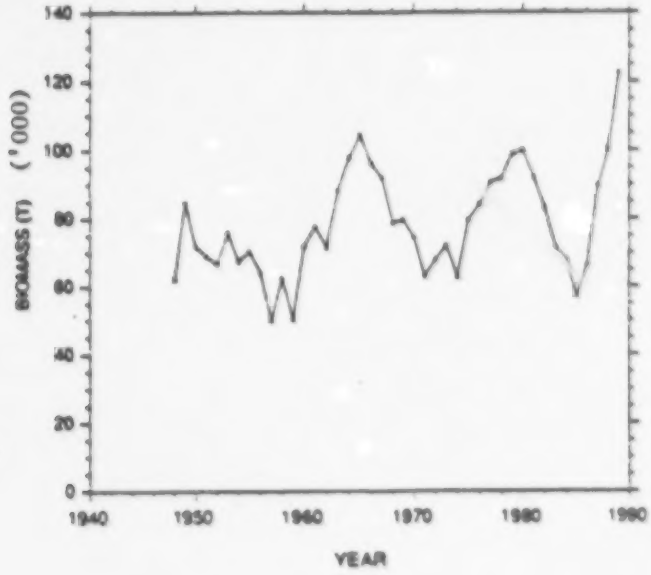


Fig. 7.5. Sequential population analysis recruitment (age 1) for 4X cod

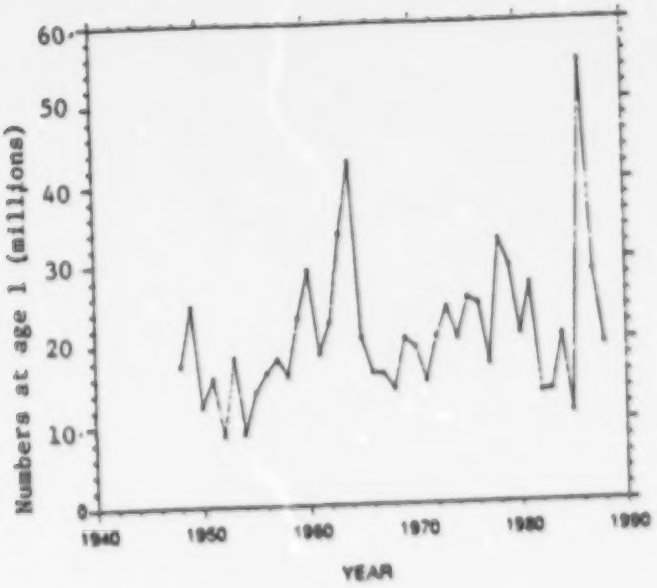



Fig. 8.1. Canadian and USA catches 5Zjm cod.

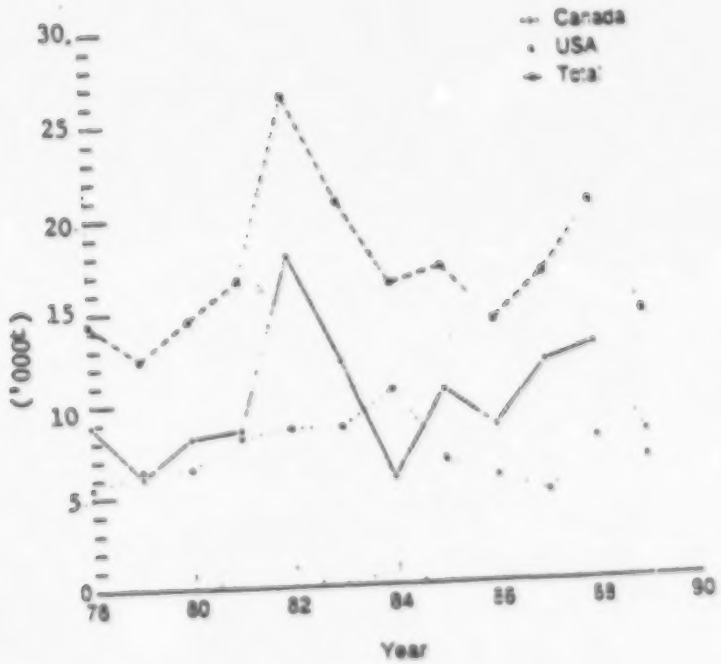


Fig. 8.2. Canadian and USA research surveys for cod in 5Zjm.

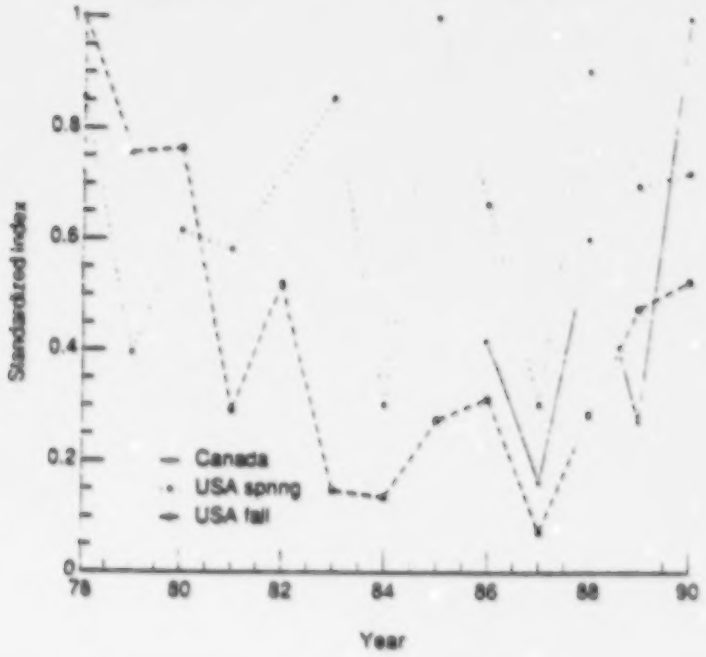



Fig. 8.3. Recruitment at age 1 for 5Zjm cod.

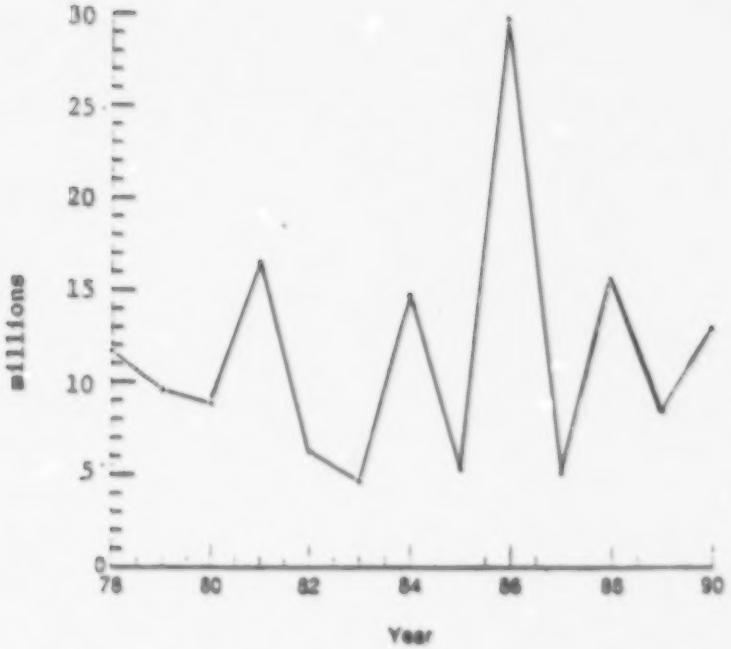


Fig. 8.4. Biomass for ages 3+ 5Zjm cod.

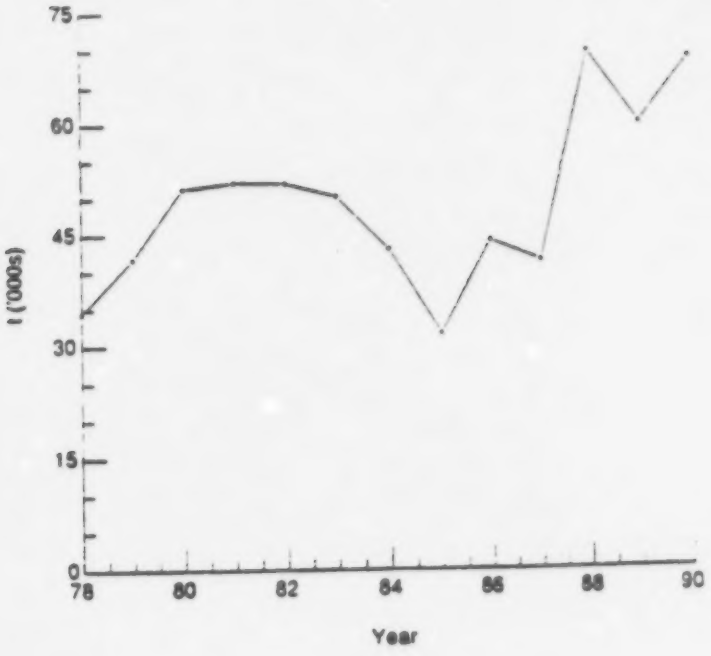



Fig. 8.5. Mean 3+ fishing mortality for 5Zjm cod.

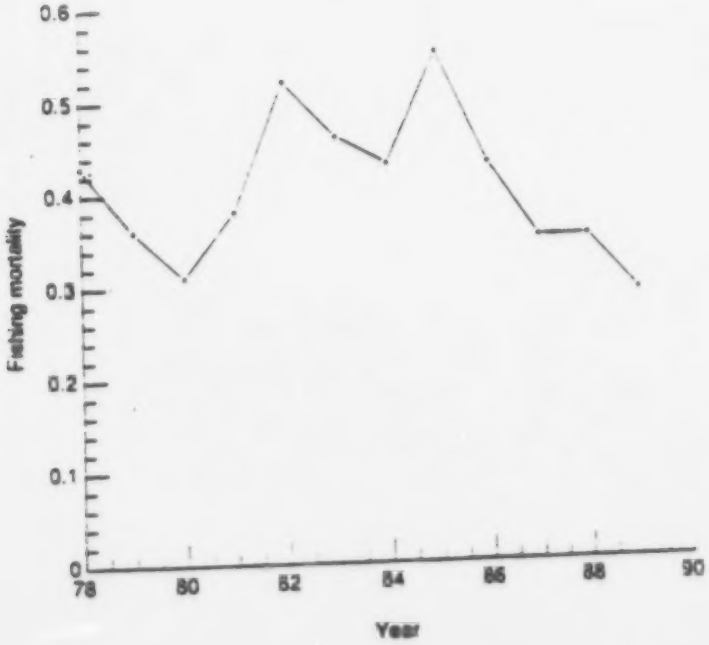


Fig. 9.1. Nominal catch and TACs for 4TVW haddock

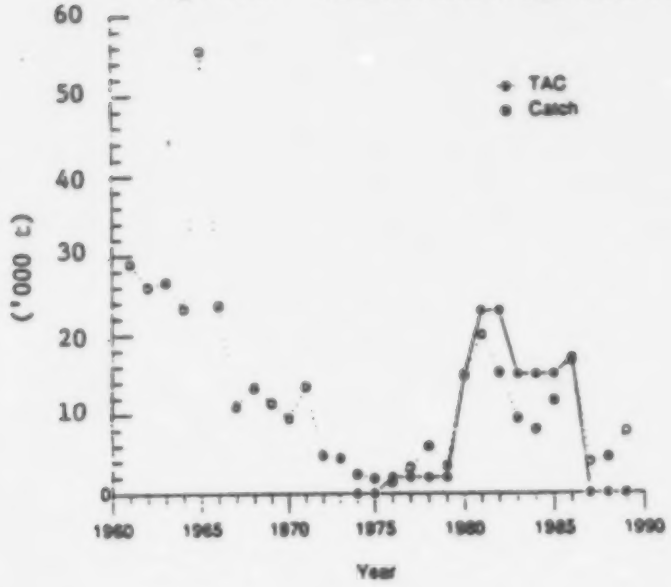



Fig. 9.2. Mean haddock catch per tow in 4VW (all ages combined)

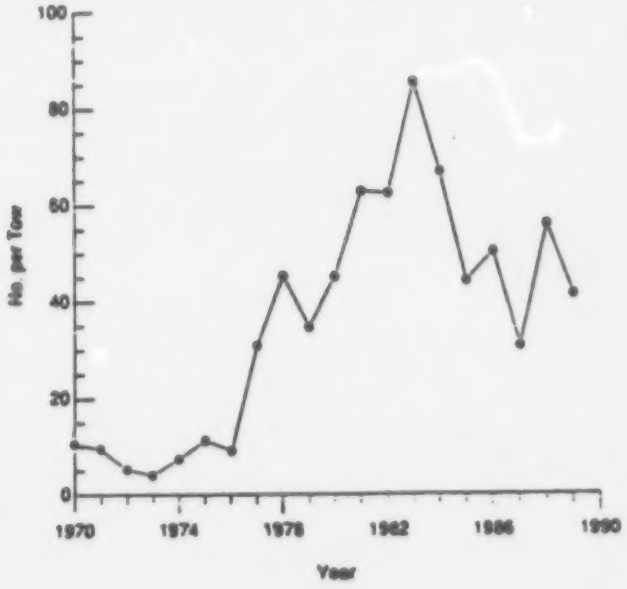


Fig. 9.3. Mean haddock catch per tow in 4W

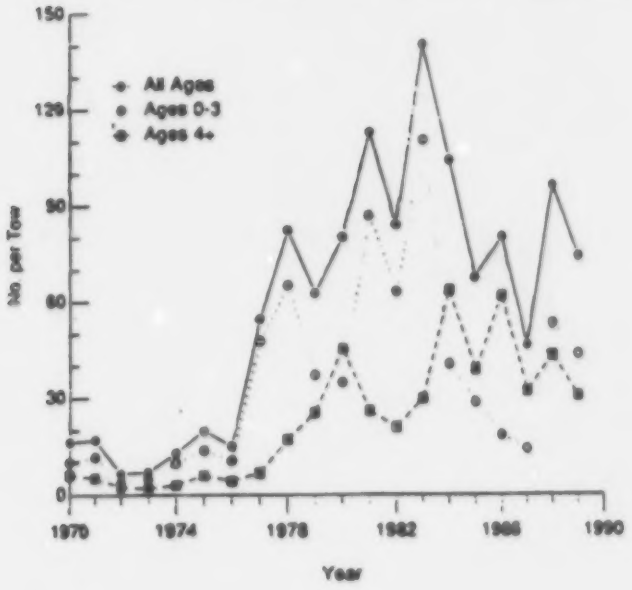



Fig. 9.4. Mean haddock catch per tow in 4Vn

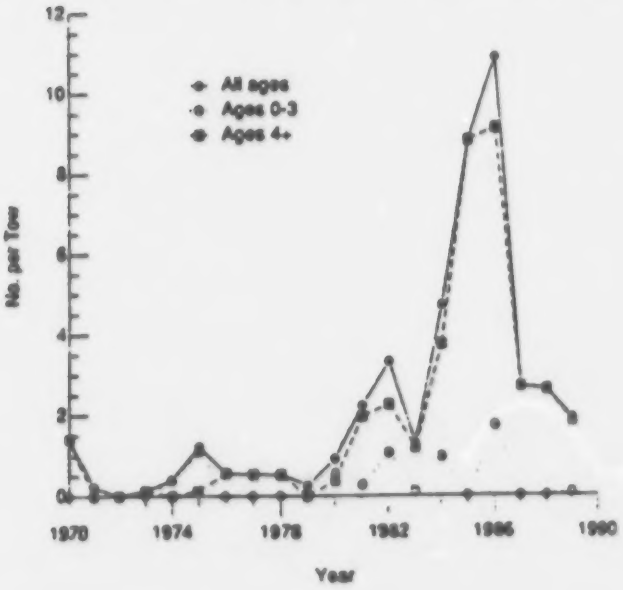


Fig. 9.5. Mean haddock catch per tow in 4Vs

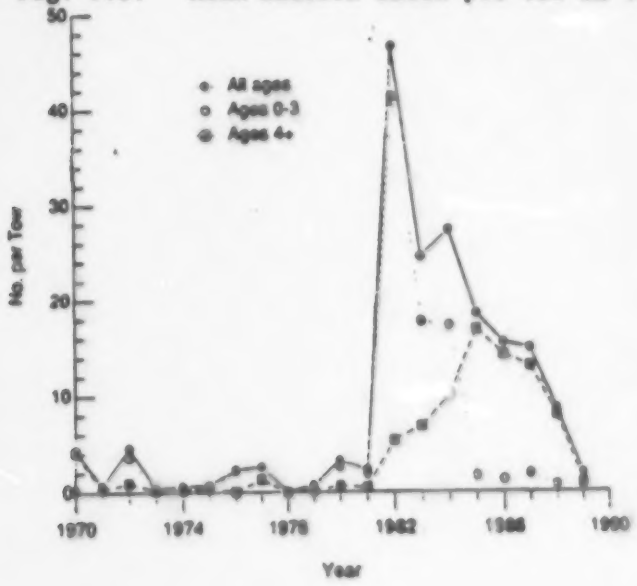



Fig. 9.6. Research vessel estimated fishing mortality (3 year running mean)

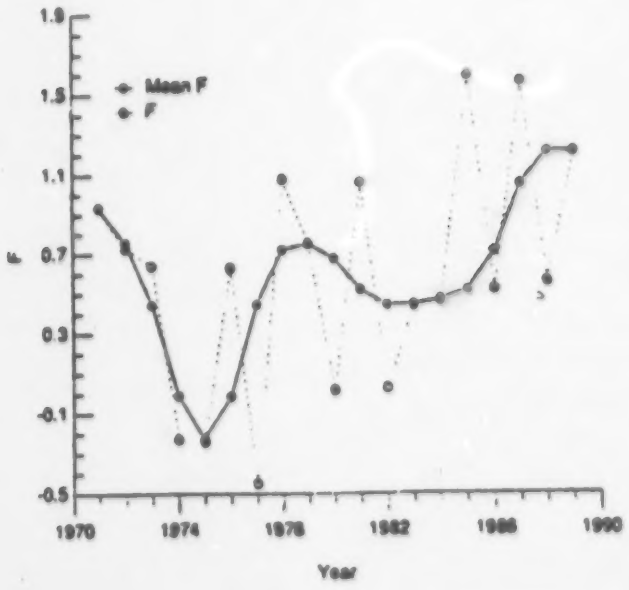


Fig. 9.7. Mean weight of a fish in the catch for 4TVW haddock

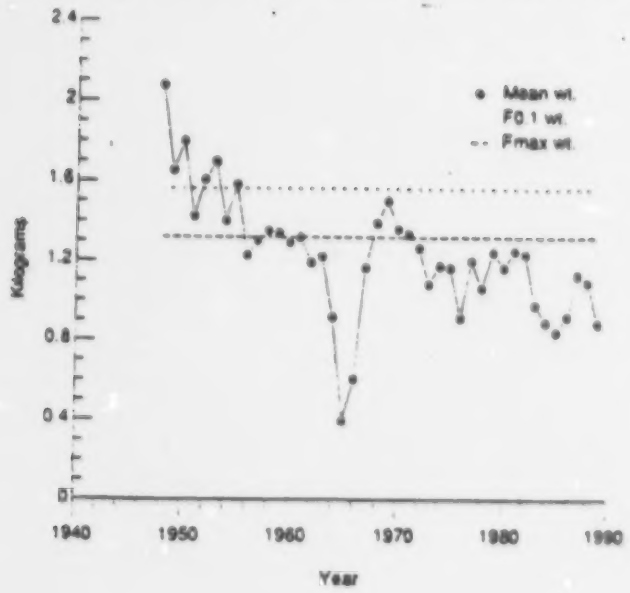


Fig. 10.1. Nominal catch and TACs for 4X haddock

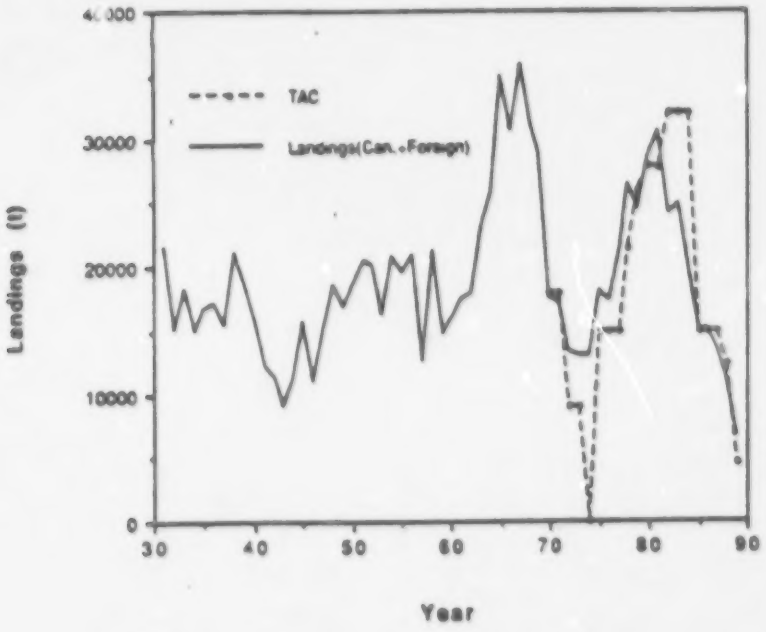



Fig. 10.2. Research vessel abundance index (mean weight per tow) for 4X haddock

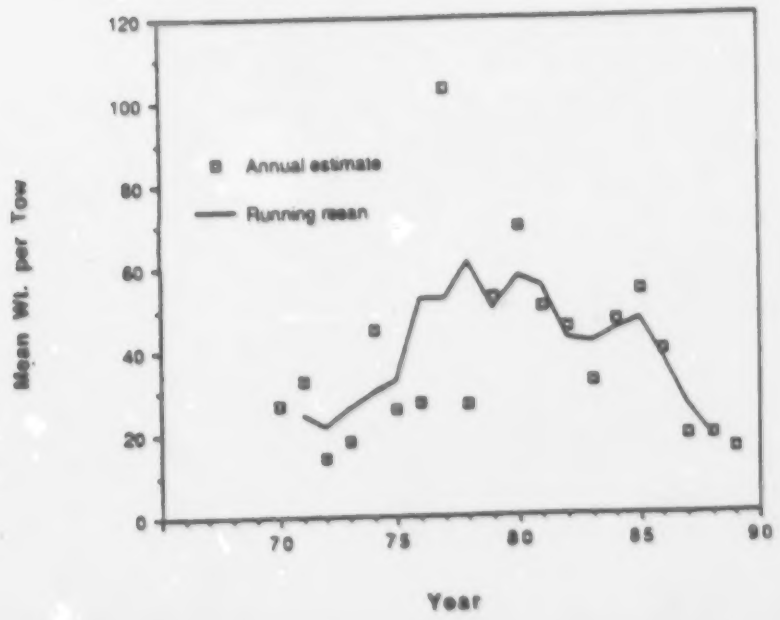


Fig. 10.3. Research vessel abundance index (mean numbers per tow) for 4X haddock

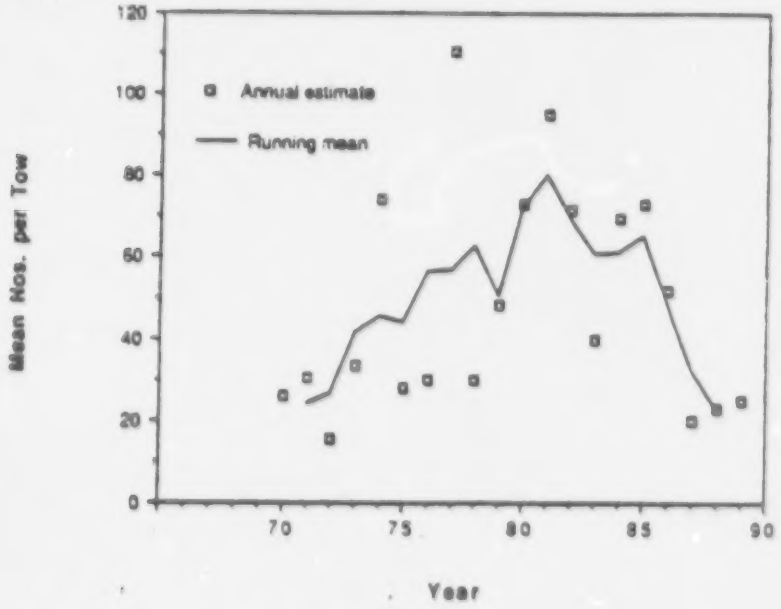


Fig. 11.1. Catch of haddock in unit areas 5Zjm.

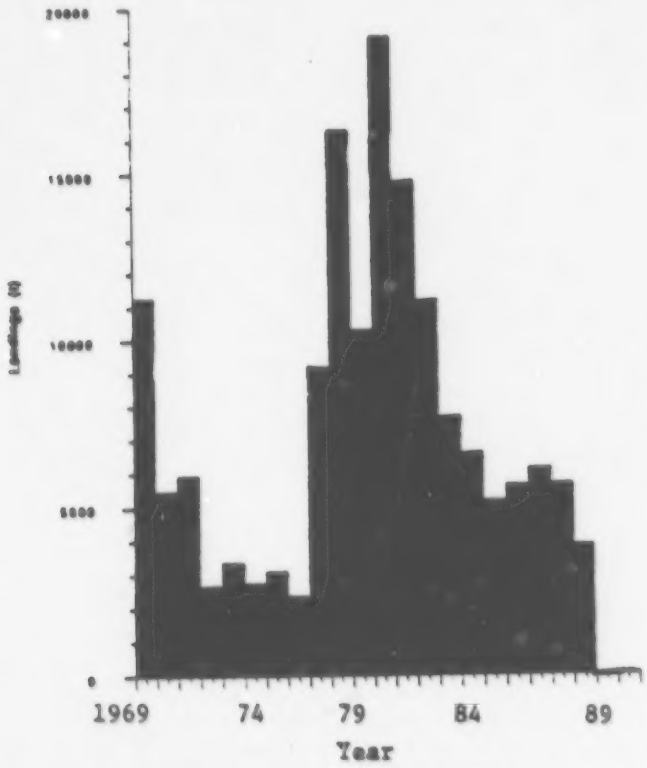



Fig. 11.2. Biomass index 5Zjm haddock.

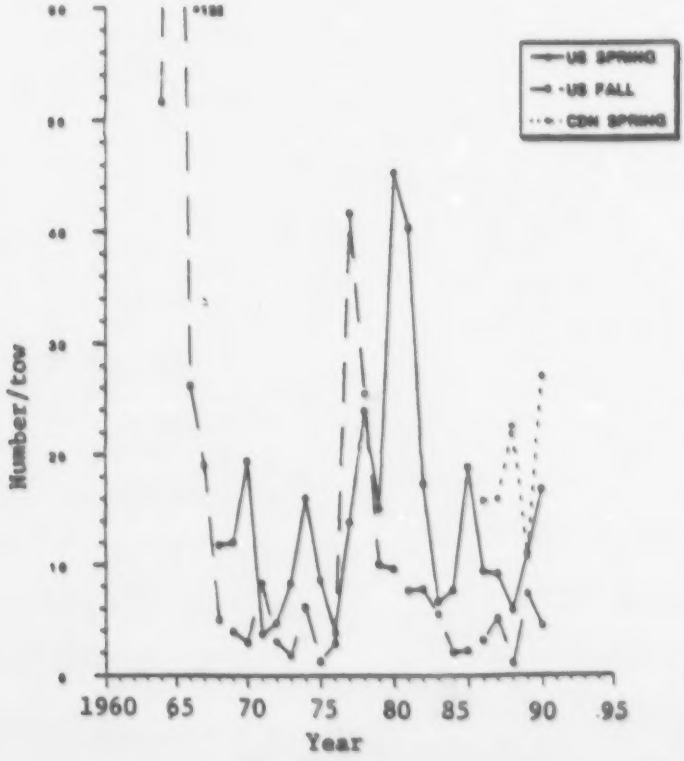


Fig. 11.3. Biomass of haddock in unit area 5Zjm.

Fig. 11.4. Fishing mortality rate for haddock unit areas 5Zjm. Ages 3+.

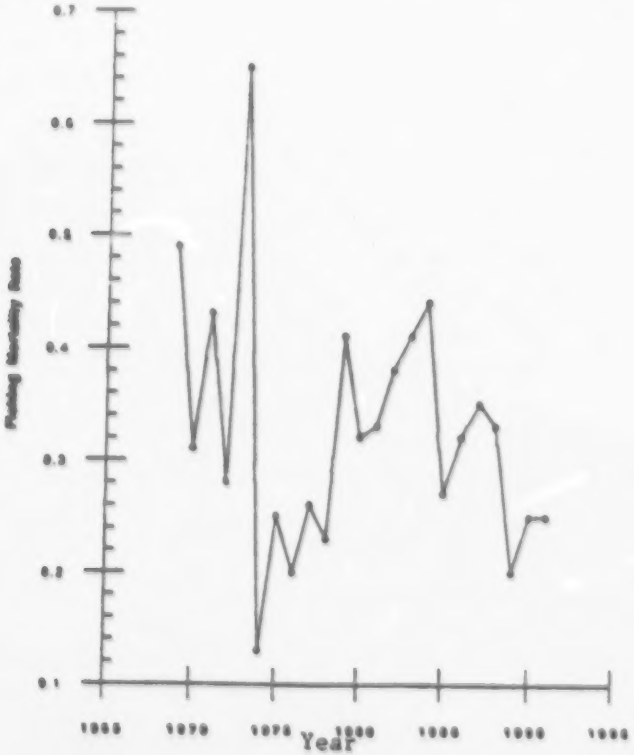


Fig. 11.5. Recruitment for haddock in unit areas 5Zjm.

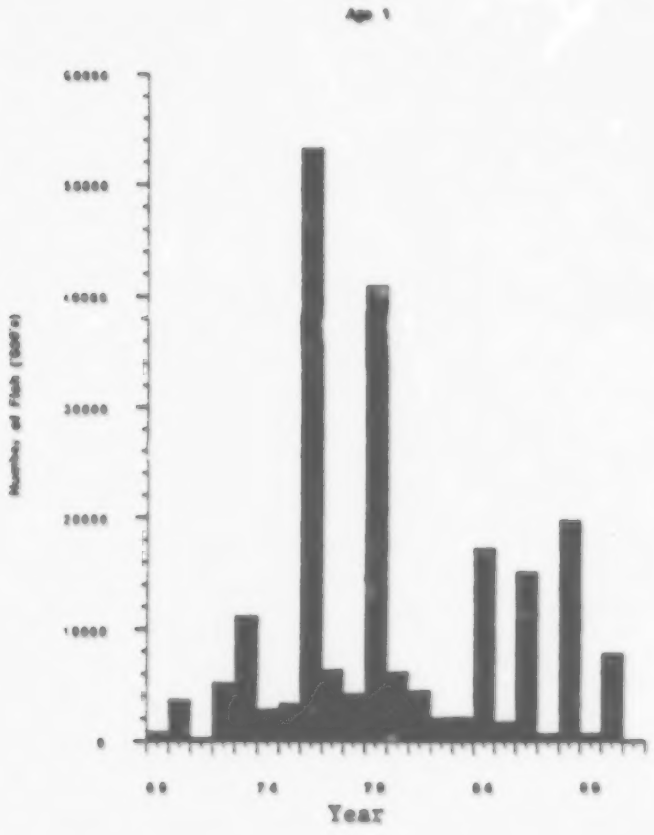


Fig. 12.1. Nominal catch and TACs for 4VWX5Z pollock

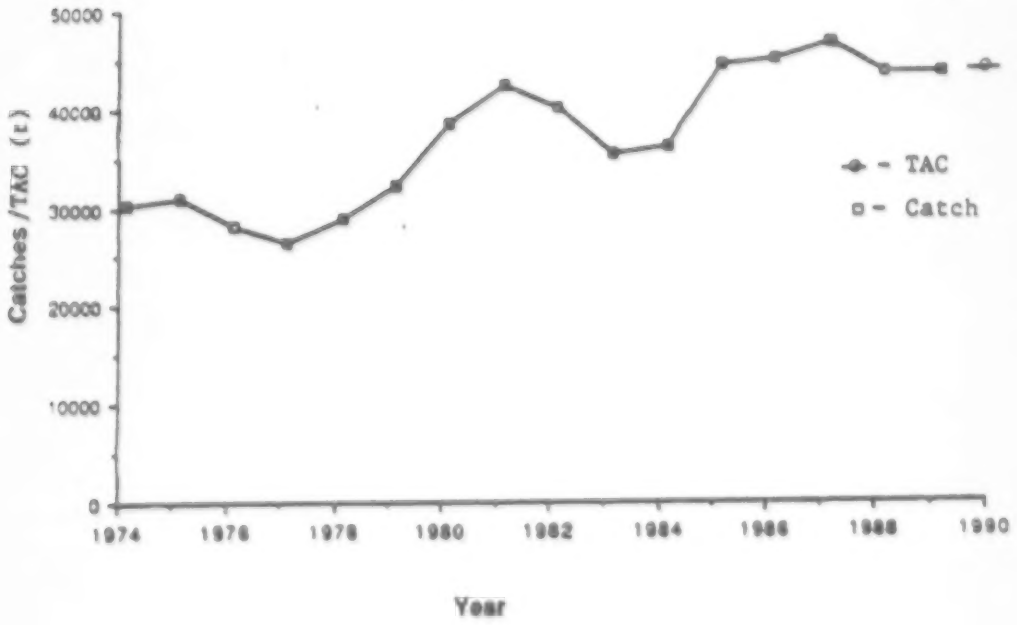



Fig. 12.2. July Research vessel stratified population estimates (ages 4-9) for 4VWX5Zc pollock.

Fig. 12.3. Age 2 recruits to 4VWX5Zc pollock

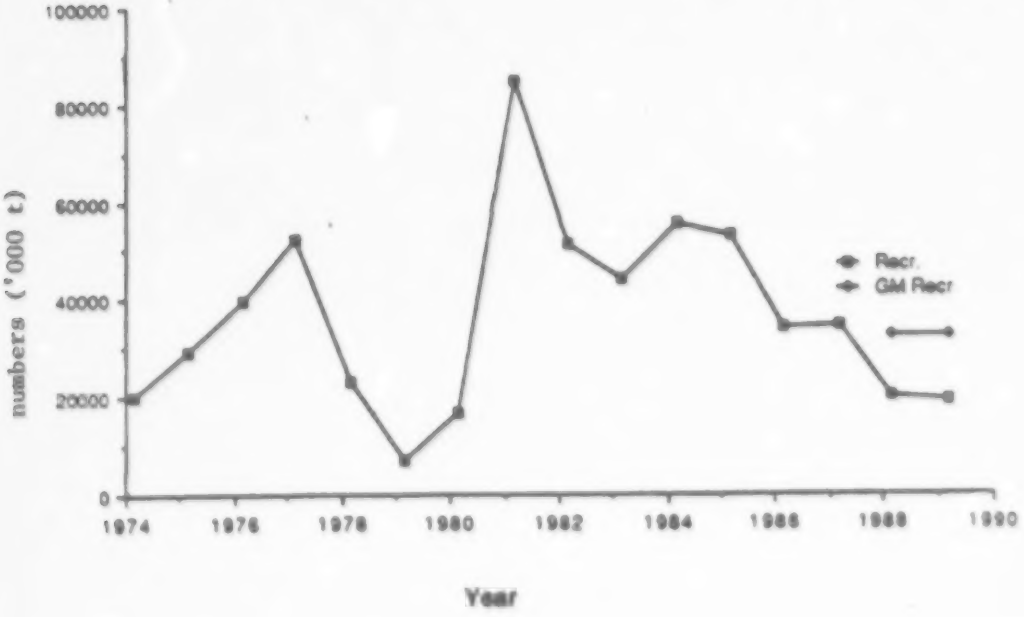



Fig. 12.4. Mid-year biomass for 4VWX5Zc pollock.

Fig. 12.5. Population numbers (ages 4-9) for 4VWX5Zc pollock.

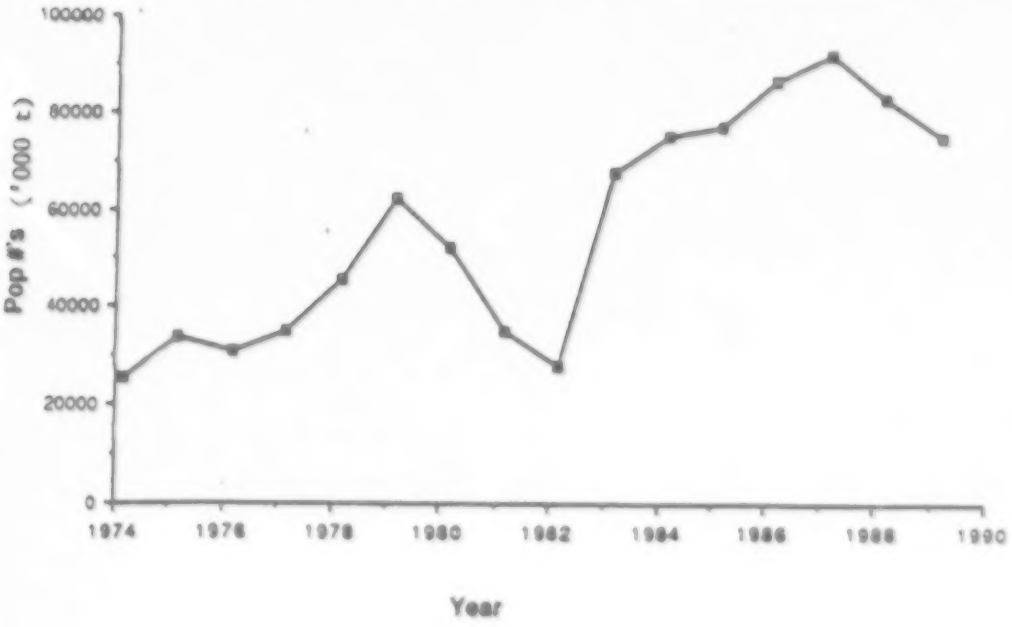



Fig. 12.6. Fully recruited F for 4VWX5Zc pollock

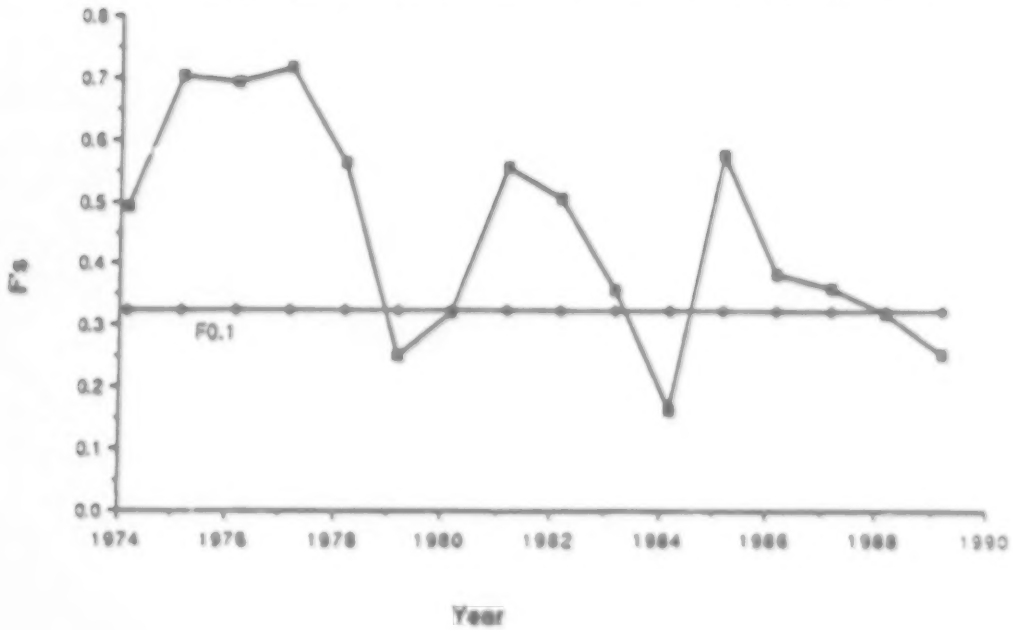


Fig. 13.1. Nominal catch and TACs for redfish in SA2 + Division 3K

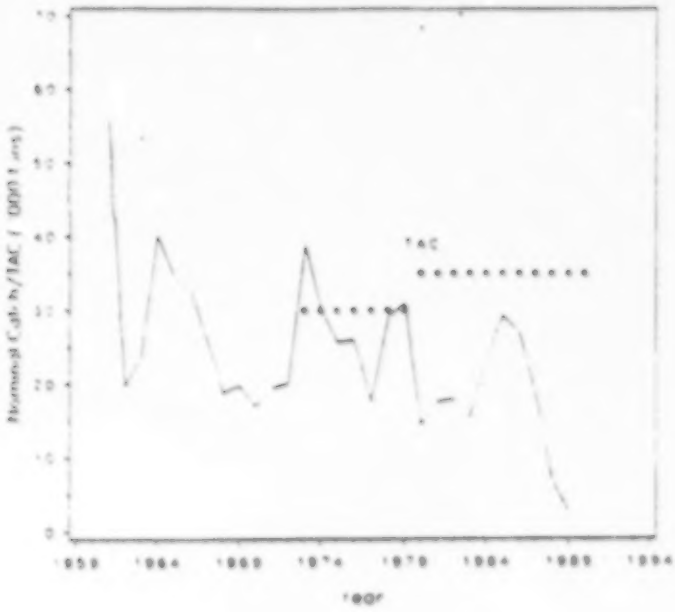



Fig. 13.2. Catch rate index for redfish in SA2 + Division 3K

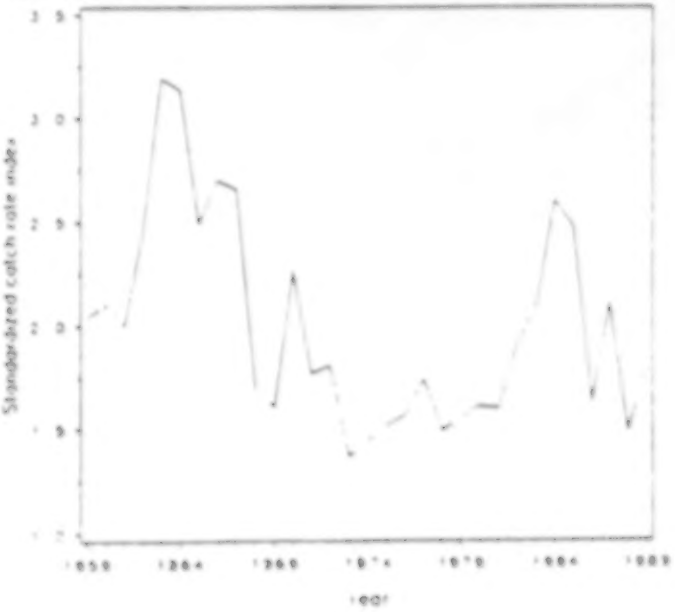


Fig. 13.3. Survey abundance index for redfish in SA 2 and Division 3K.

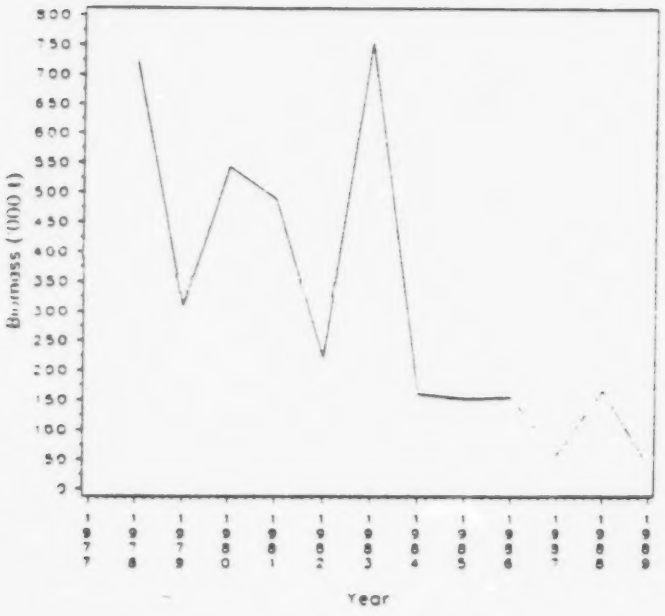



Fig. 14.1. Nominal catch and TACs for Division 30 redfish.

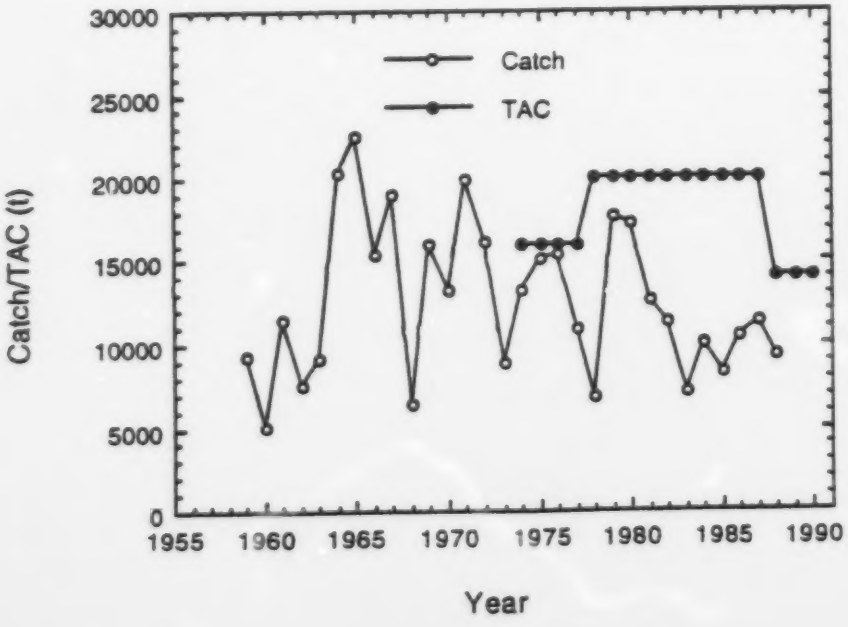
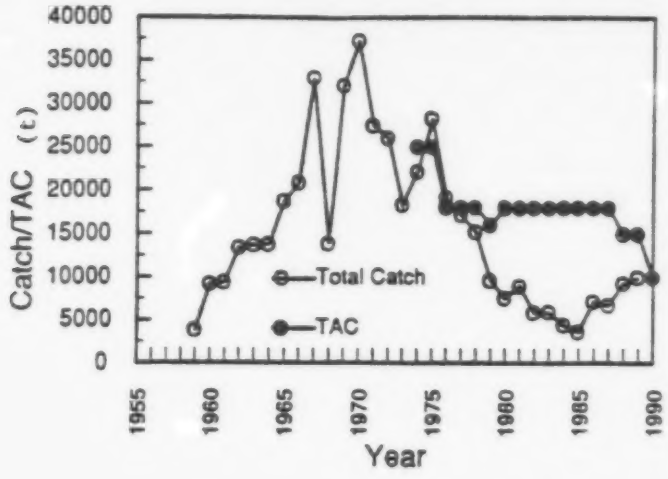


Fig. 15.1. Nominal catches and TACs for Division 3P redfish



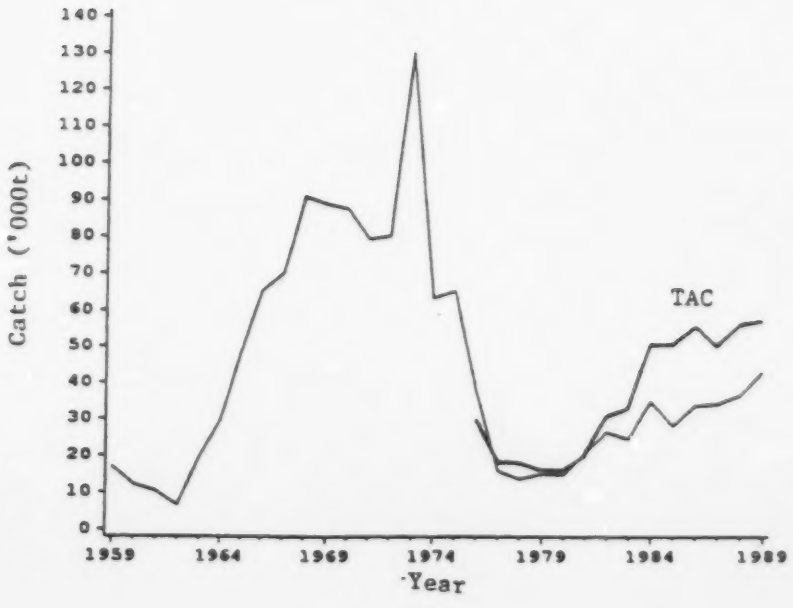




Fig. 16.1. Nominal catch and TACs for divisions 4RST redfish

Fig. 16.2. Standardized catch rates (t/hr) for redfish in Division 4RST.

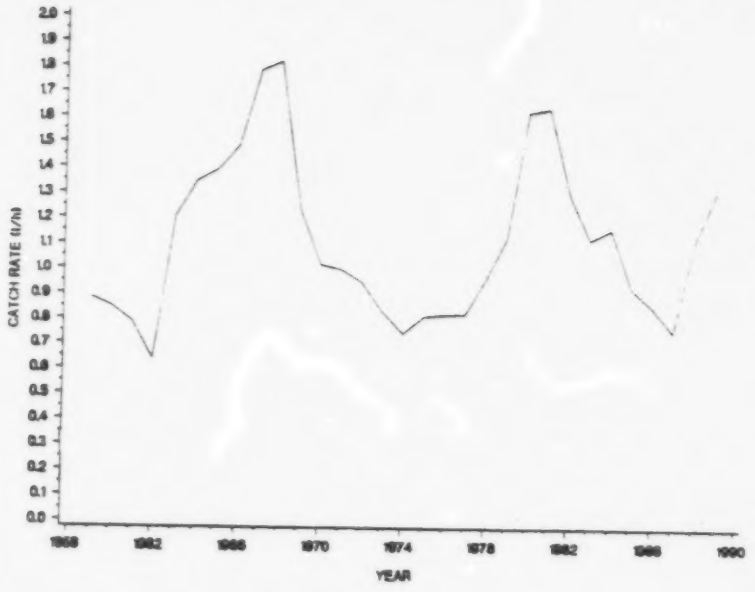
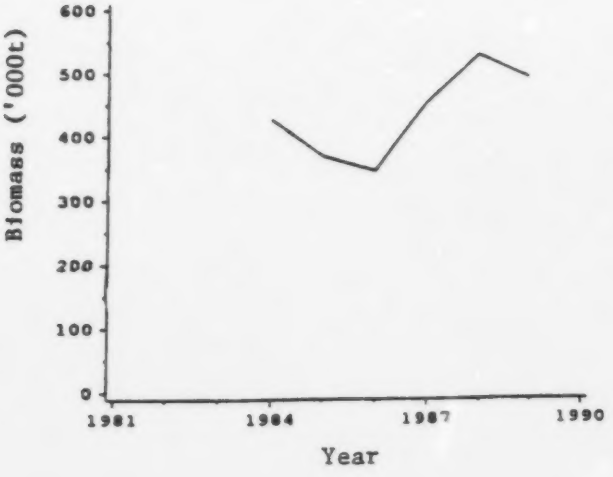



Fig. 16.3. Research vessel biomass estimates 4RST redfish



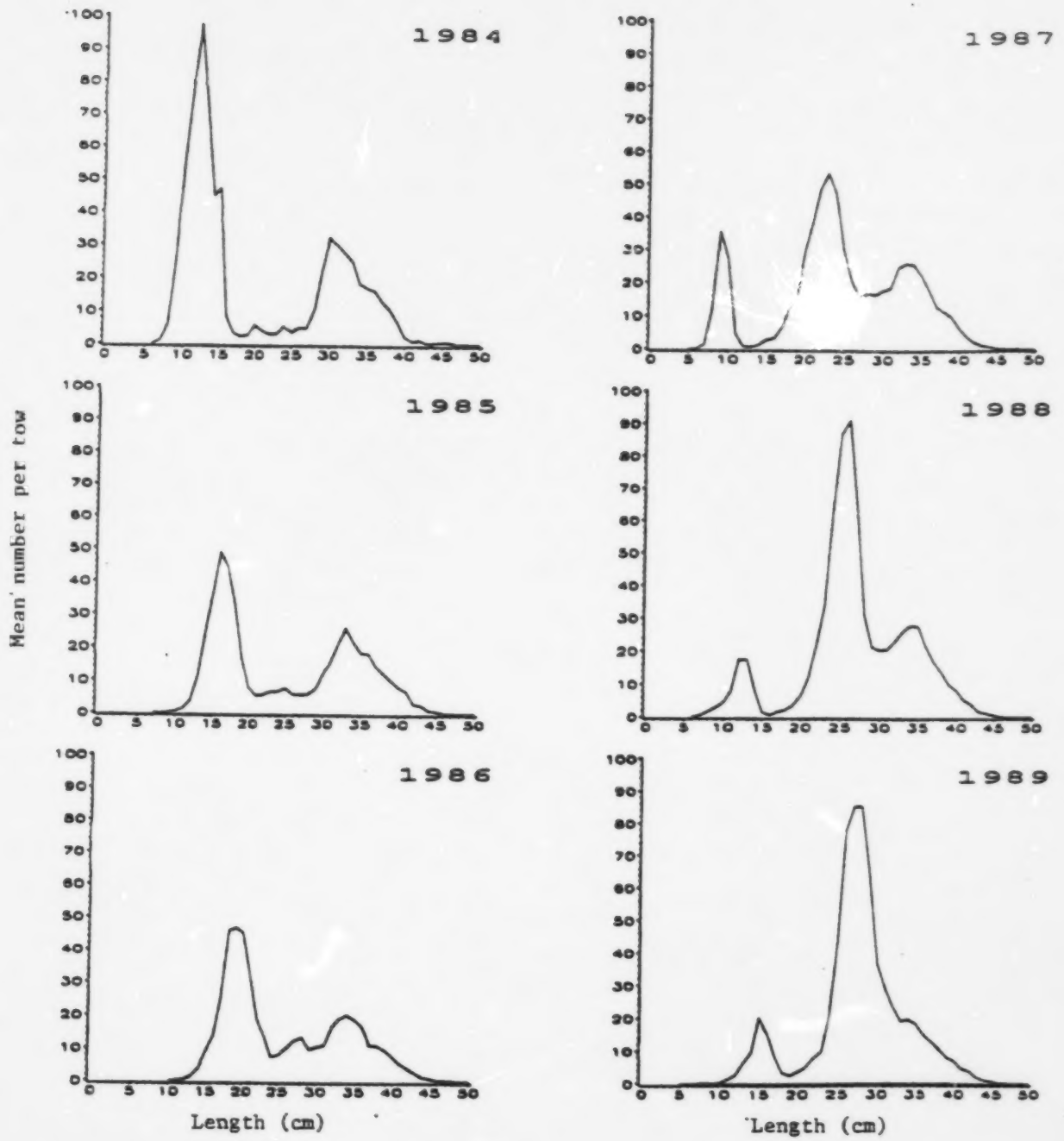



Fig. 16.4. Research vessel length frequencies 4RST redfish

Fig. 17.1 Nominal catch and TACs for divisions 4VWX redfish.

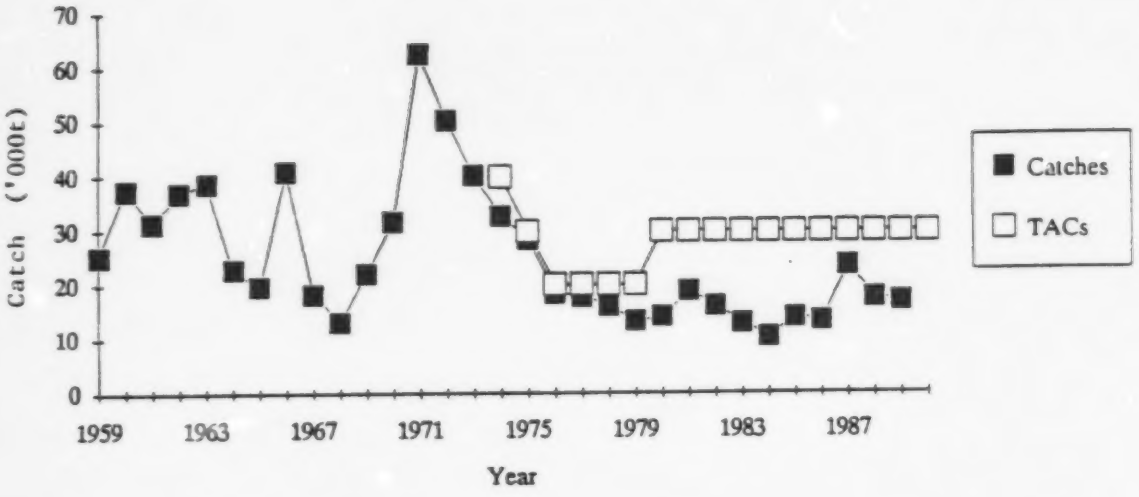



Fig. 18.1. Nominal catch and TACs for SA2 and Division 3K American plaice.

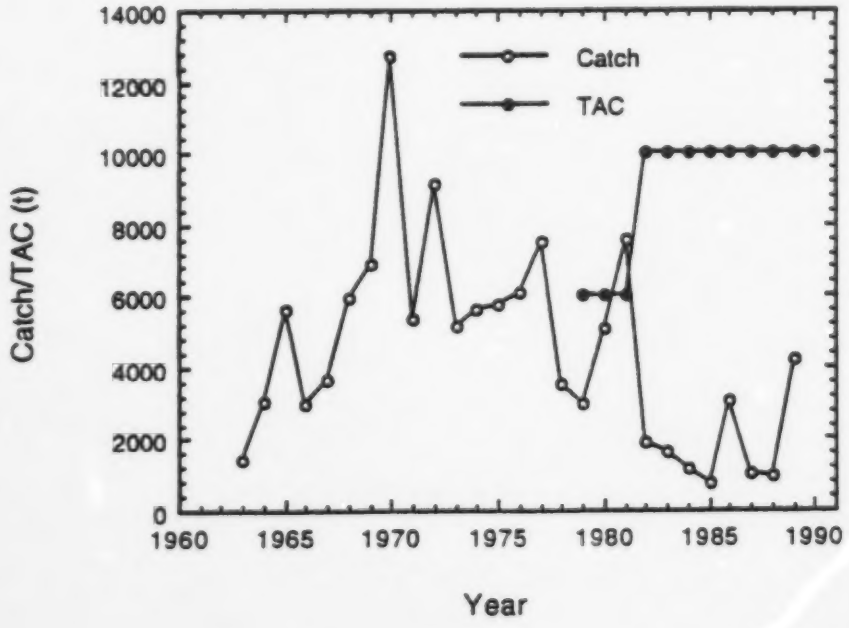


Fig. 19.1. Nominal catch and TACs for Subdivision 3Ps American Plaice

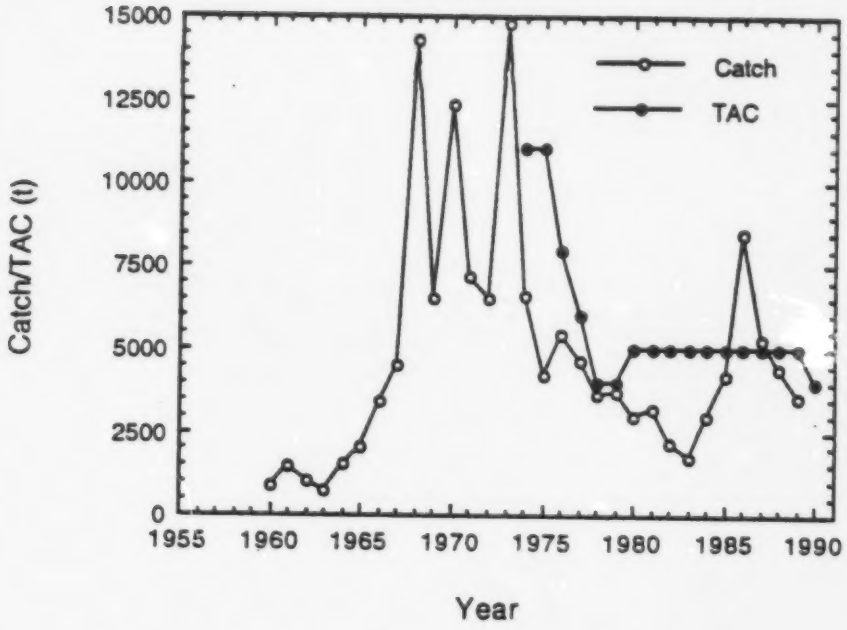


Fig. 20.1. Nominal catch and TACs for Division 4T American plaice

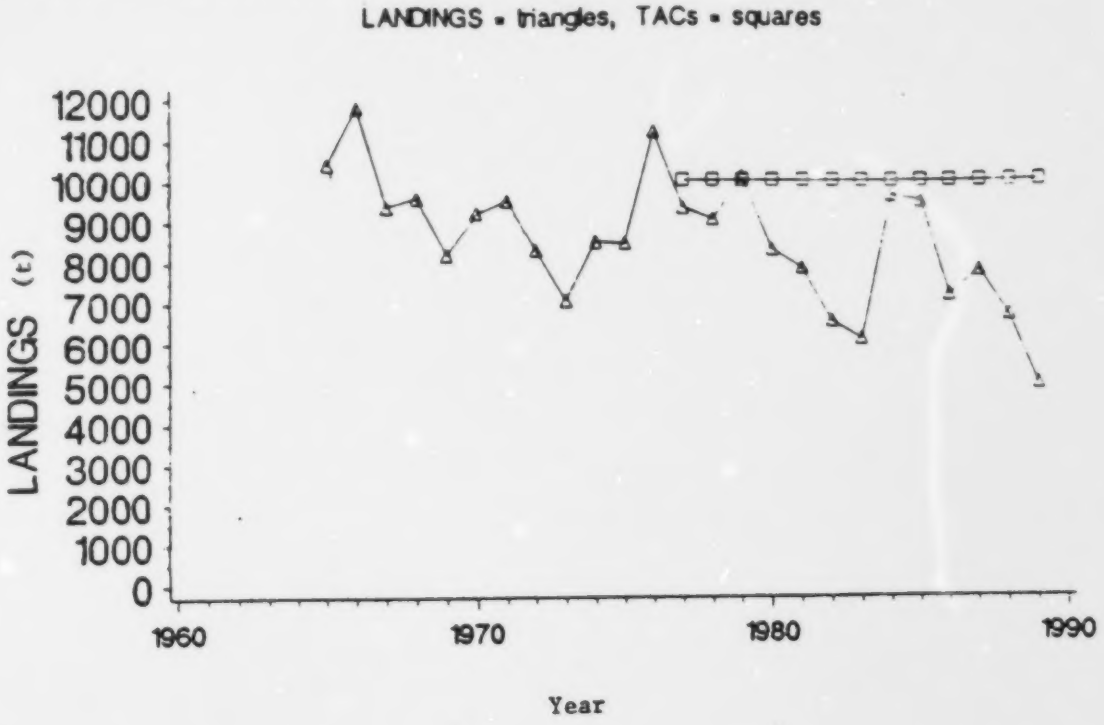



Fig. 20.2. Mean number per tow from research vessel survey for American plaice in Division 4T.

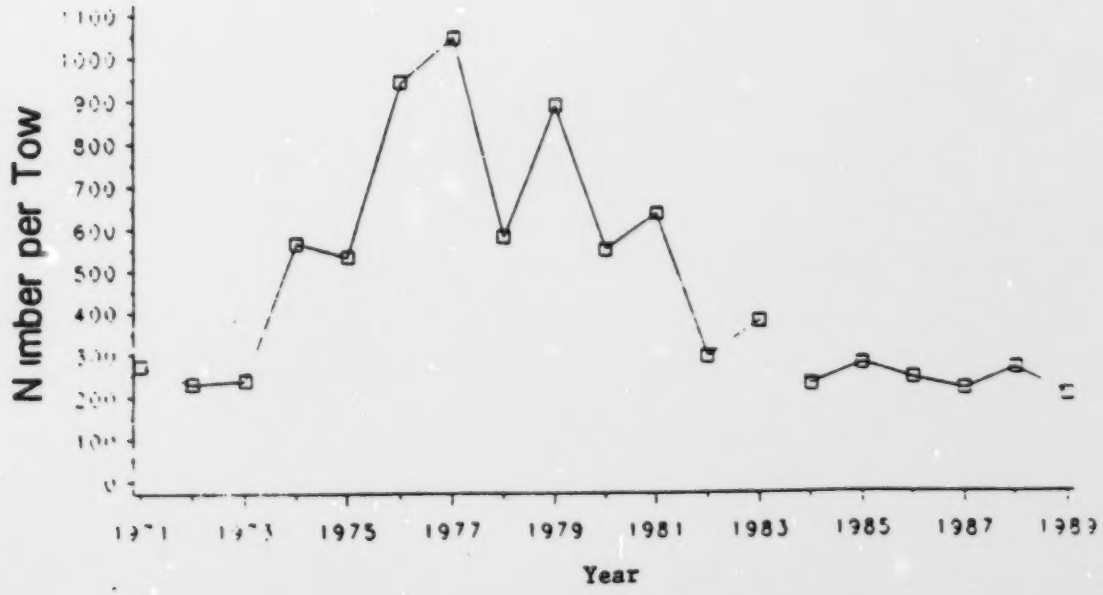


Fig. 21.1. Nominal catch and TACs for Division 2J3KL witch.

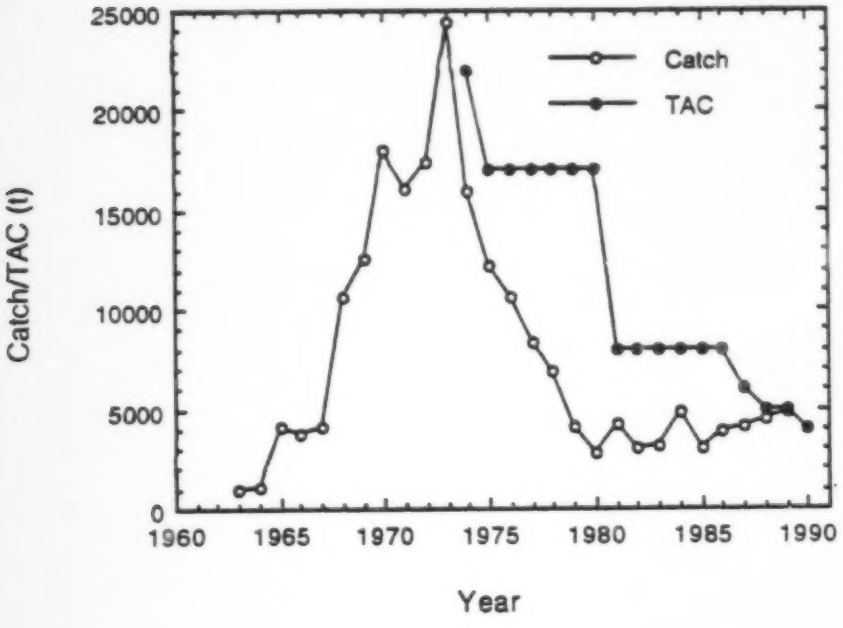



Fig. 22.1. Nominal catch and TACs for Subdivision 3Ps witch.

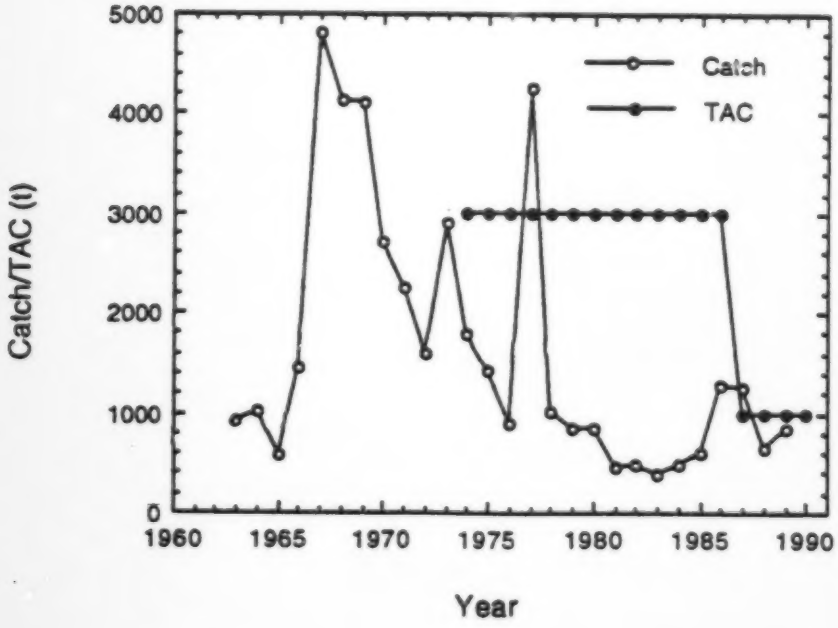


Fig. 23.1. Nominal catch and TACs for Division 4RS witch

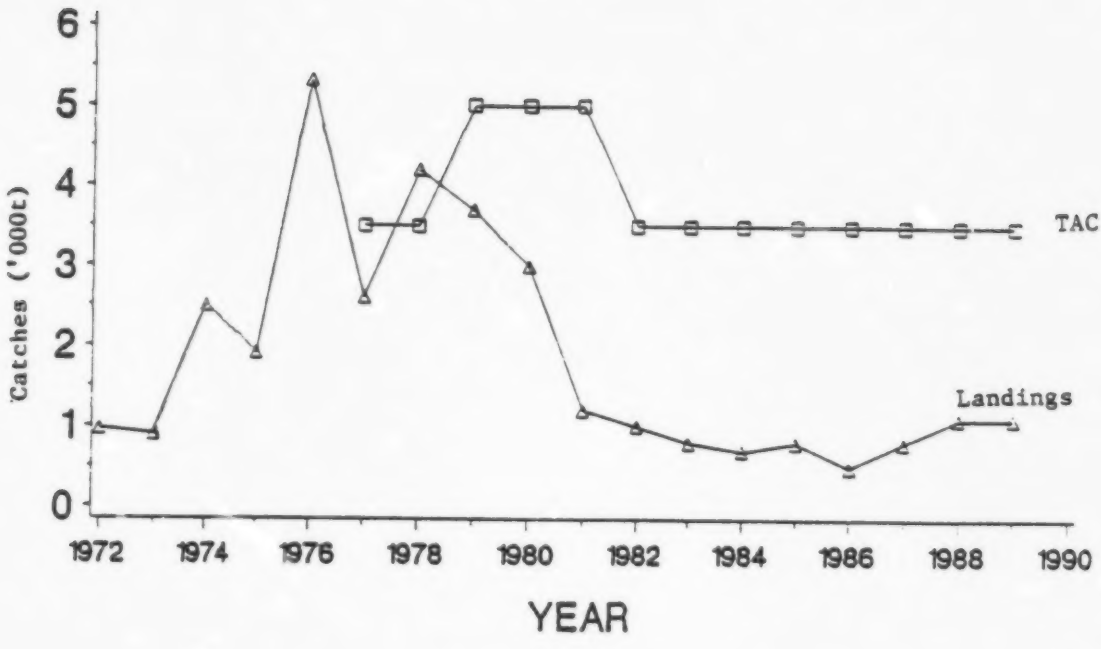



Fig. 24.1. Nominal catch and TACs for 3NOPs and 4VWX Atlantic halibut.

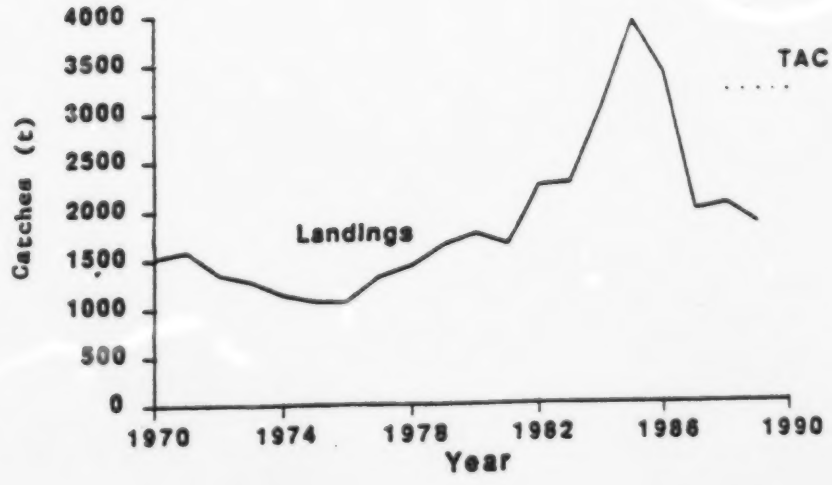


Fig. 25.1. Nominal catch and TACs for divisions 4RST Atlantic halibut

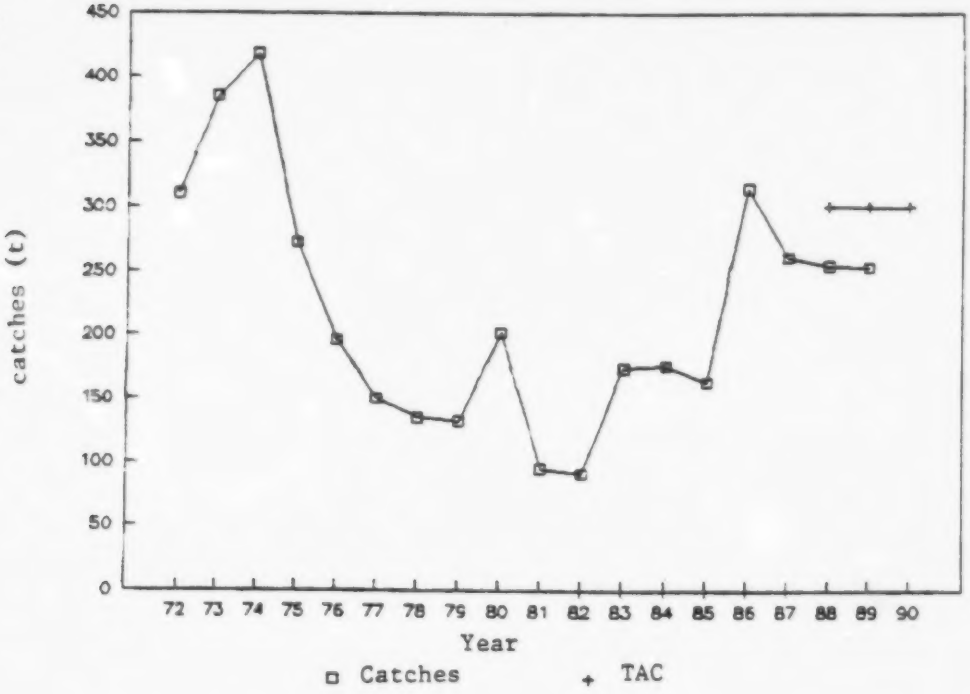



Fig. 26.1. Nominal catch and TACs for divisions 4RST Greenland halibut

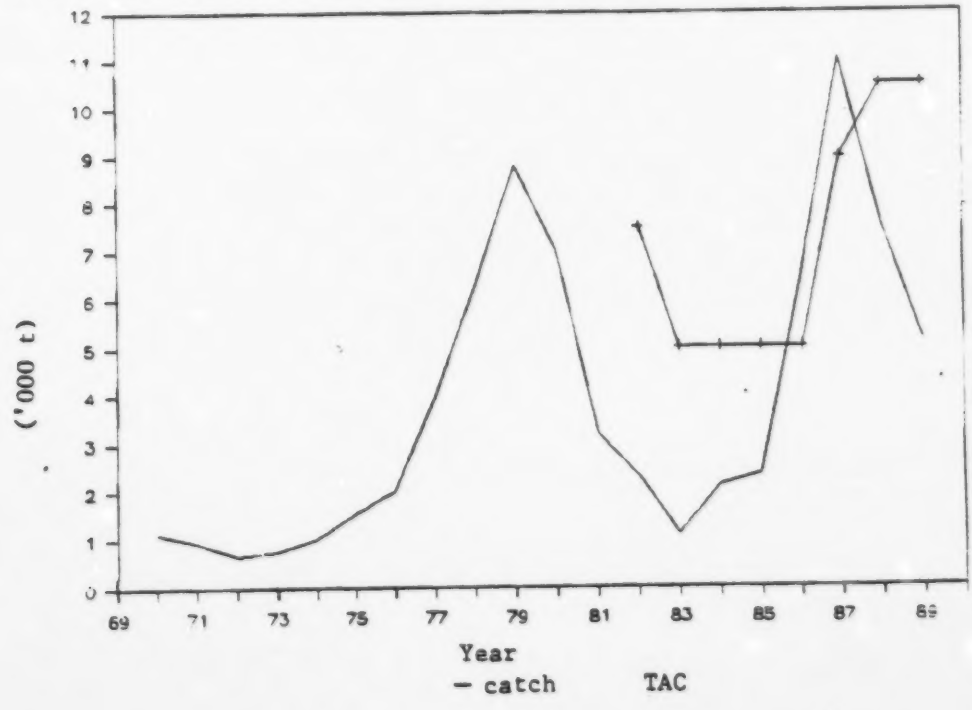


Fig. 27.1. Nominal catch and TACs for divisions 4VWX flatfish.

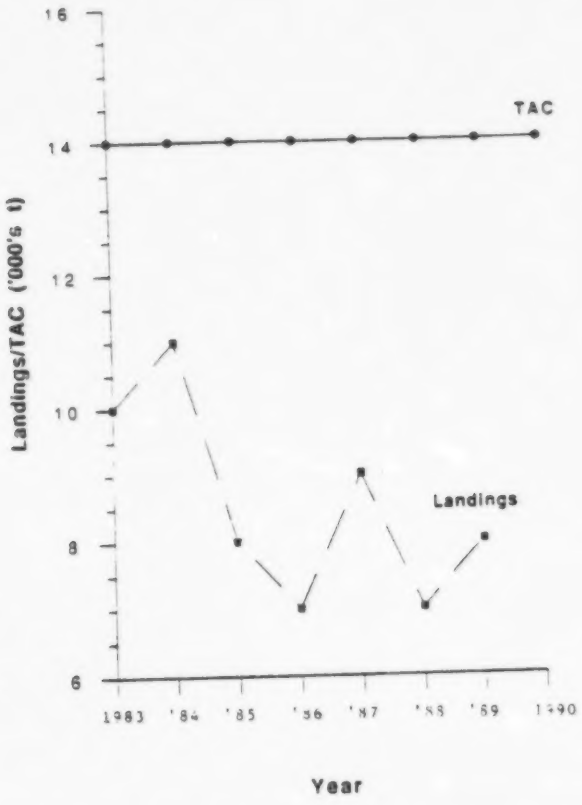



Fig. 28.1. Nominal catch and TACs for Division 4T white hake.

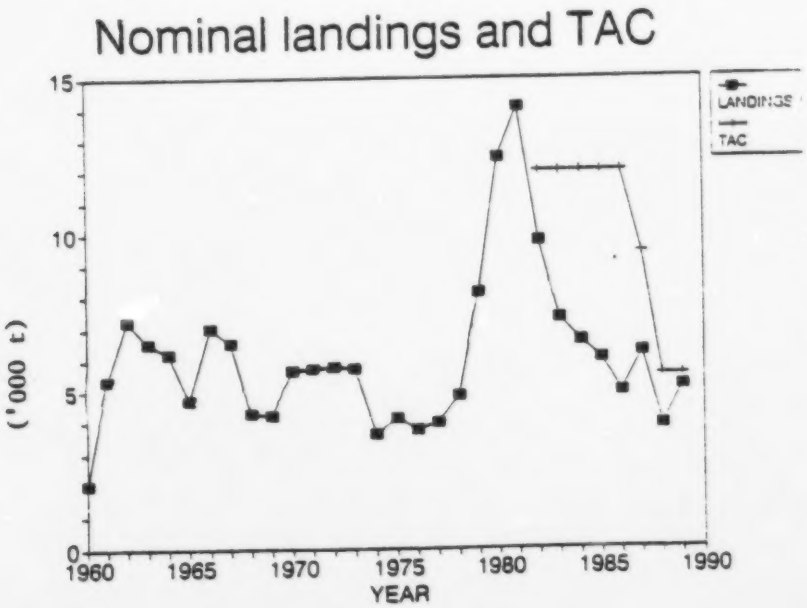
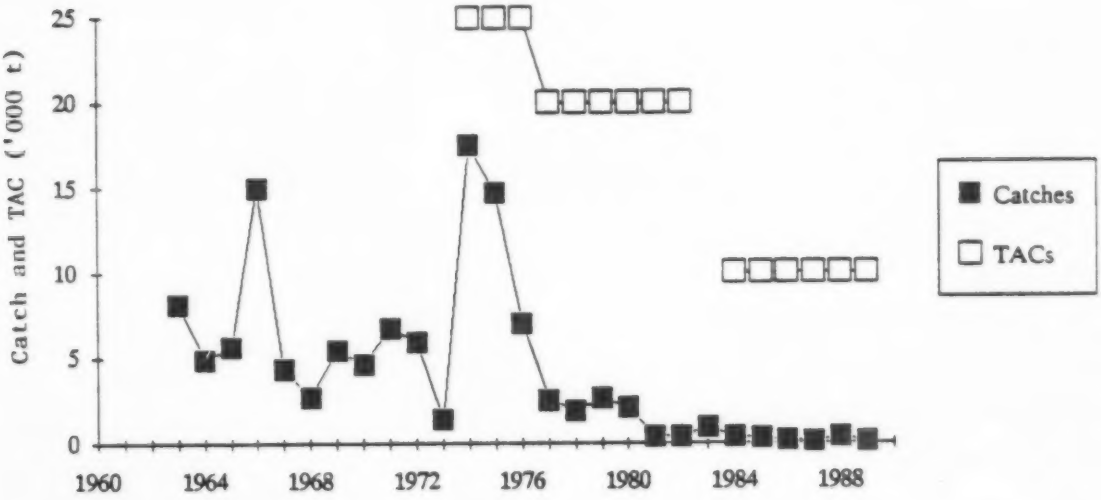


Fig. 29.1. Nominal catch and TACs for divisions 4VWX argentine.



Summary of Groundfish Advice, 1990 - Résumé des conseils relatifs aux poisson de fond, 1990.

| Stock | Nominal catches/Prises nominales ('000 t) | | | | | | TACs set/TPA fixés ('000 t) | | | | | | | Reference Level for 1991/ Niveau de référence pour 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1987[a] | 1988[a] | 1989[a] | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | |
| COD/MORUE | | | | | | | | | | | | | | |
| 2GH | 2 | 1 | 1 | + | + | + | 20 | 20 | 20 | 20 | 20 | 20 | 20 | (20)[i] |
| 2J3KL | 232 | 231 | 252 | 235 | 266 | 240 | 266 | 266 | 266 | 256 | 266 | 235 | 197 | (100-215) |
| 4RS3Pn | 104 | 88 | 80 | 67 | 48 | 47 | 100 | 100 | 92.1 | 80.3[d] | 73.9[d] | 76.5 | 58 | ()[g] |
| 4TVn(J-A) | 55 | 62 | 64 | 51 | 52 | 50 | 67 | 67 | 60 | 45.2[d] | 54 | 54 | 53 | (48-53) |
| 4Vn(M-D) | 10 | 13 | 12 | 10 | 9 | 8 | 14 | 12 | 12 | 9 | 7.5[d] | 7.5 | 7.5 | (7.5-10) |
| 4VsW | 53 | 57 | 52 | 46 | 38 | 37 | 55 | 55 | 48 | 44 | 38 | 35.2[d] | 35.2[d] | (21-35) |
| 4X | 25 | 21 | 20 | 19 | 19 | 20 | 30 | 30 | 20 | 17.5 | 14 | 12.5[mn] | 22[d] | (20) |
| 5Zjm[c] | 17 | 17 | 15 | 17 | 20 | 15 | 45[h] | 25[d] | 11[j] | 12.5[d] | 12.5[d] | 8[j] | N/A | (11-22) |
| HADDOCK/AIGLEFIN | | | | | | | | | | | | | | |
| 4TVW | 8 | 11 | 17 | 4 | 5 | 8 | 15 | 15 | 17 | J | J | 6.7 | 6 | ()[i] |
| 4X | 20 | 15 | 15 | 14 | 11 | 7 | 32 | 15 | 15 | 15 | 12.4[d] | 4.6[d] | 4.6[d] | ()[i] |
| 5Zjm[c] | 7 | 5 | 6 | 6 | 6 | 4 | 20[h] | 5.1[j] | 5.1[j] | 8.3[j] | 8.3[j] | 8.3[j] | N/A | (5.4) |
| POLLOCK/GOBERGE | | | | | | | | | | | | | | |
| 4VWX+5Zc[c] | 35 | 44 | 44 | 46 | 43 | 43 | 53[h] | 42[d] | 40[d] | 43[d] | 43[d] | 43[d,k] | 43[d,q] | (43) |
| REDFISH/SEBASTE | | | | | | | | | | | | | | |
| 2+3K | 24 | 29 | 27 | 19 | 7 | 3 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | (20) |
| 3O | 10 | 8 | 10 | 13 | 10 | 4 | 20 | 20 | 20 | 20 | 14 | 14 | 14 | (14)[p] |
| 3P | 4 | 4 | 7 | 7 | 9 | 10 | 18 | 18 | 18 | 18 | 15 | 15 | 10 | (15) |
| 4RST | 35 | 28 | 34 | 34 | 36 | 43 | 50.6 | 50.6 | 55.6 | 50 | 56 | 57 | 57 | (57) |
| 4VWX | 10 | 14 | 13 | 24 | 18 | 17 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | (30) |
| AMERICAN PLAICE/PLIE CANADIENNE | | | | | | | | | | | | | | |
| 2+3K | 1 | 1 | 3 | 1 | 1 | 4 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | (10) |
| 3Ps | 3 | 4 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | (4) |
| 4T[e] | 10 | 10 | 7 | 8 | 7 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | (10) |
| WITCH/PLIE GRISE | | | | | | | | | | | | | | |
| 2J3KL | 5 | 3 | 4 | 4 | 4 | 5 | 8 | 8 | 8 | 6 | 5 | 5 | 4 | (4) |
| 3Ps | + | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | (1) |
| 4RS | 1 | 1 | 1 | 1 | 1 | 1 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | (3.5) |
| ATLANTIC HALIBUT/FLETAN ATLANTIQUE | | | | | | | | | | | | | | |
| 3NOPs+ +4WVX+5Zc | 3 | 4 | 3 | 2 | 2 | 2 | - | - | - | - | 3.2 | 3.2 | 3.2 | (3.2)[p] |
| 4RST | + | + | + | + | + | + | - | - | - | - | 0.3 | 0.3 | 0.3 | (0.3)[p] |
| GREENLAND HALIBUT/FLETAN DU GROENLAND | | | | | | | | | | | | | | |
| 4RST | 2 | 2 | 7 | 11 | 8 | 5 | 5 | 5 | 5 | 8.9 | 10.5 | 10.5 | 10.5 | ()[i] |
| FLATFISH/POISSONS PLATS | | | | | | | | | | | | | | |
| 4VWX | 11 | 8 | 8 | 9 | 7 | 8 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | (10) |
| WHITE HAKE/MERLUCHE BLANCHE | | | | | | | | | | | | | | |
| 4T | 7 | 6 | 5 | 6 | 4 | 5 | 12 | 12 | 12 | 9.4[d] | 5.5[d] | 5.5 | 5.5 | ()[i] |
| ARGENTINE/ARGENTINES | | | | | | | | | | | | | | |
| 4VWX | + | + | + | + | + | + | 10 | 10 | 10 | 10 | 10 | 10 | 10 | (10) |

[a] Provisional statistics.
[b] American plaice and 90% of those recorded as "Flatfish not specified".
[c] Catches and advice for new management unit.
[d] 50% rule applied.
[e] Canadian allocation for Subarea 5.
[f] Canadian allocations for the management unit used prior to 1990.
[g] Precautionary TAC.
[i] Information inadequate to provide advice.
[j] No TAC by-catch only.
[k] The mobile gear fleet <65' quota for 4VWX+5Zc was included under the cod/haddock/pollock management plan in 4X.
[m] Cod/haddock/pollock allocation for 1989.
[n] Includes US allocation.
[o] No increase in mobile gear catch.

[a] Statistiques provisoires.
[b] Plie canadienne ainsi que 90 % de celles inscrites en tant que "poissons plats non-identifiés."
[c] Prises et avis pour une nouvelle unité de gestion.
[d] Règle de 50 % en vigeur.
[e] Allocation canadienne pour la Sous-zone 5.
[f] Allocations canadiennes pour les unités de gestion en vigueur avant 1990.
[g] TPA préventif seulement.
[i] Renseignements insuffisants pour la formulation d'un avis
[j] Aucun TPA, prises accidentelles seulement.
[k] L'allocation de la flottille á engin mobile de moins de 65 pieds pour 4VWX+5Zc a été inclus au plan de gestion de la morue, de l'aiglefin et de la goberge en 4X.
[m] Allocation de morue-aiglefin-goberge pour 1989.
[n] Comprend les allocations réservées aux E.U.
[o] Pas d'augmentation des captures des engins mobiles.

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Advisory Document 90/6

# Advice on the management of mackerel in the northwest Atlantic

## Introduction

Mackerel in the northwest Atlantic are managed as a single stock despite the existence of two separate spawning groups. The northern contingent of the stock spawns in the southern Gulf of St. Lawrence in June and July whereas the southern contingent spawns in April-May between Cape Cod and Cape Hatteras. The two contingents are believed to share approximately the same overwintering grounds in subareas 5 and 6 from the end of December to about mid-March.

## Description of the fishery

The Canadian fishery off Nova Scotia and in the southern Gulf of St. Lawrence is mostly a summer fishery using traps, gillnets and handlines. The autumn fishery off Newfoundland is conducted primarily by large purse seiners on the west coast and by small purse seiners off the east coast. The fishery in USA waters is conducted both by American vessels, and through joint arrangements, by European vessels. The United States domestic fishery was mostly a summer fishery while the midwater trawl joint ventures occur mostly in the winter. Catches in the winter fishery have increased from less than 1,000 t in 1980 to about 43,000 t in 1988 with the domestic USA fishery occurring more and more during the winter in recent years as a result of direct over-the-side sales.

The mackerel fishery expanded rapidly in the late 1960s early 1970s on overwintering concentrations in subareas 5 and 6 and catches peaked at 430,000 t in 1973 (Fig. 1). Poland, Bulgaria, the German Democratic Republic and the USSR were the major participants. This winter fishery was halted in 1977-1978 when Canada and the USA extended their jurisdiction to 200 miles. Mackerel catches since 1978 have varied between 27,500 t and 88,000 t averaging about 51,000 t. Preliminary catches in 1989 were 71,735 t a decrease of more than 16,000 t from 1988. Recent nominal catches ('000 t) are as follows:

| | 1984 | 1985 | 1986 | 1987[1] | 1988[1] | 1989[1] | 1990 |
|---|---|---|---|---|---|---|---|
| Reference level | - | - | - | 200 | 200 | 200 | 200 |
| SA 3-4 | 17.0 | 29.9 | 31.1 | 22.1 | 23.3 | 18.7 | |
| SA 5-6 | 23.6 | 42.9 | 39.8 | 54.4 | 64.7 | 53.0 | |
| Total | 40.6 | 72.7 | 70.9 | 76.6 | 88.0 | 71.7 | |

[1]Catches are preliminary

Canadian catches have varied between 16,000 t and 31,000 t since 1978, averaging 23,000 t over the period. In 1989, Canadian catches were almost 18,700 t, a decrease of more than 4,600 t compared to 1988. The catches were lower in all divisions except in Division 4R where an over-the-side-sales agreement with the USSR has helped keep the catches high for the past three years. By contrast, catches from the east coast of Newfoundland (divisions 3K and 3L) have been declining steadily over the past five years.

Canada has not set a TAC for mackerel since 1977 because catches were anticipated to be, and actually were, much lower than would have been allowable at a reference level such as $F_{0.1}$. In recent years, CAFSAC has concluded that

catches of about 200,000 t divided equally between Canada and the USA were unlikely to endanger the stock.

The 1989 catch was similar to recent years in that it was dominated by the strong 1982 year-class. The 1987 year-class may also be strong.

Indices of abundance

An in-depth analysis of Canadian catch-per-unit-of-effort data based on purchase slip information since 1984 showed that catch-per-unit-of-effort trends differed greatly among divisions. CAFSAC believes that these catch rate indices probably reflect availability and markets more than abundance. It is possible that better catch and effort information from Subdivision 4Vn, through which most of the northern contingent is believed to migrate, could provide a better index of abundance.

The Department of Fisheries and Oceans has been conducting surveys to assess mackerel egg abundance in the southern Gulf of St. Lawrence (Division 4T) since 1979 with the objective of estimating spawning stock biomass. The index of total annual egg production for 1989 decreased three-fold compared with 1988 but the 1990 index increased to previous levels and suggests a biomass of about 1 million tons for the northern contingent.

Assessment and forecast

A precise assessment of northwest Atlantic mackerel is not possible at this time because the exploitation rate appears low and there are no reliable indices of stock size. However, the egg production index suggests that the biomass of the northern contingent alone could be about 1 million tons. The 1982 year-class was strong, maybe as strong or stronger than the 1967 year-class which supported catches much higher than those supported by the 1982 year-class. In addition, the 1989 catches suggest that the 1987 year-class may also be strong. CAFSAC therefore concludes that catches in the order of those since 1985, that is about 80,000 t, in 1991 would result in a low exploitation rate and that catches of 200,000 t divided equally between Canada and the USA are unlikely to be harmful to the stock. CAFSAC cautions that catches higher than 200,000 t would not be appropriate until more information on stock status is available.

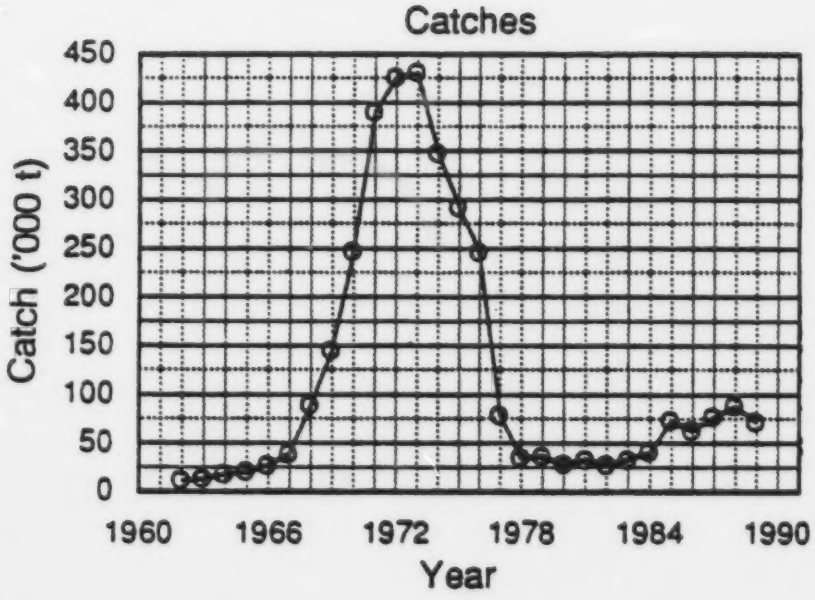



Fig. 1. Catches of Subarea 3-6 mackerel.

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Advisory Document 90/7

## Gulf of St. Lawrence snow crab

### Snow crab off Prince Edward Island

Exploitation of snow crab off P.E.I. started as an experimental fishery in 1985 and there are now 30 licenses involved. Until 1989 there was both a spring and an autumn fishery but no autumn fishing was allowed after 1988 because the fishing effort and catches in the spring have been enough to generate the target exploitation rate.

Information is available from logbooks, sales slips (except for 1990, because of insufficient time to compile the information), sampling of the catches at sea, and a trawl survey conducted after the fishing season. Information on fishing effort, catches and catch per unit of effort is presented in the following table:

| | Effort (# of hauls) | | Catch (t) | | | CPUE (kg/trap) | |
|---|---|---|---|---|---|---|---|
| | Spring | Fall | Spring | Fall | Total | Spring | Fall |
| 1985 | 11,756 | 3,404 | 673 | 129 | 802 | 57 | 38 |
| 1986 | 30,824 | 7,182 | 1,008 | 231 | 1,239 | 33 | 32 |
| 1987 | 19,069 | 5,919 | 288 | 169 | 457 | 15 | 28 |
| 1988 | 16,478 | 4,813 | 437 | 229 | 666 | 26 | 48 |
| 1989 | 15,726 | - | 747 | - | 747 | 47 | - |
| 1990 | 22,016 | - | 546 | - | 546 | 25 | - |

Estimates of biomass for 1989, 1990 and 1991 are available from trawl surveys conducted in 1988, 1989 and 1990 but because of low sampling intensity, the estimates are not precise despite doubling the number of stations in 1990. The results of the 1990 survey are given in the following table:

| | Biomass[1] | | |
|---|---|---|---|
| | Lower Limit | Mean | Upper Limit |
| 1989 | 98 | 472 | 1,042 |
| 1990 | 24 | 1,298 | 2,572 |
| 1991 | 375 | 1,325 | 2,275 |

[1]The biomass is estimated for the fishing season following the survey.

Applying the target exploitation rate of 50-60% to the biomass estimate implies a 1991 reference catch of 650-700 t. However, considering that the confidence interval for the 1991 biomass estimate ranges from a low of 375 t to a high of 2,275 t, CAFSAC considers that the information may not be sufficiently precise to justify a change in TAC.

As indicated in the previous advisory document on snow crab (CAFSAC Adv. Doc. 90/1) the indications are that snow crab in the P.E.I. zones do not

constitute biological units distinct from the neighbouring management units. The biomass and fishing effort distributions suggest that snow crab in Zone 25 are continuous with Cape Breton snow crab while distributions in Zone 26 appear continuous with Zone 12.

Southwest Gulf of St. Lawrence snow crab

The exploitation of snow crab in the southwest Gulf of St. Lawrence began in 1966 and by 1969, catches totalled close to 7,600 t. From 1970 to 1976, catches varied between 4,600 t and 7,600 t and in 1977, total catches were 9,500 t. Catches peaked at 31,500 t in 1982 and then fluctuated between 24,000 t and 26,000 t before falling sharply to close to 12,000 t in 1987-88. Catches continued to decline in 1989 and 1990, totalling 7,900 t and 6,950 t respectively.

In 1990, the fishery was limited by a quota of 7,000 t, which was divided into individual quotas per vessel. Landings were rigorously recorded by weighmasters present at all landing points and the management plan provided for an immediate halt of fishing activities when catches consisted of 20% or more of newly molted crab.

The data presented in this advisory document are drawn from an analysis of logbooks, sales slips (except for 1990, since sales slips were unavailable at the time of the analysis), a sampling of catches at sea and trawl surveys for estimating biomass. In calculating minimum trawlable biomass, only crabs that are morphometrically mature are included and it is assumed that these crabs will no longer molt--that is, they have reached their terminal molt. Morphometrically immature crabs are excluded from the calculation because it is assumed that these crabs will remain white crab since they will molt every year until they reach maturity, at which time they complete their terminal molt.

The fishing effort in Baie des Chaleurs increased in 1990 over 1989, as indicated by the geographic distribution of legal-sized crabs revealed by the 1989 Nephrops trawl survey. The total number of trap hauls in 1990 was estimated at approximately 250,000, a substantial decline from the 356,000 hauls in 1989 and the 529,000 hauls in 1988. The catch per unit of effort in 1990 was higher than in 1987-89, but the comparison is questionable because 1990 was the first year in which the fishermen were allocated individual quotas. In addition, they were given maps indicating the geographic distribution of hard-shelled crab

based on the 1989 trawl survey. Information on fishing effort, catches and catch-per-unit of effort is presented below:

| | Effort (# of hauls) | Catch (t) | CPUE (kg/traps) |
|---|---|---|---|
| 1968 | 129,914 | 3,939 | 30.3 |
| 1969 | 198,015 | 2,580 | 38.3 |
| 1970 | 107,890 | 5,634 | 52.2 |
| 1971 | 113,113 | 5,374 | 47.5 |
| 1972 | 127,833 | 5,392 | 42.2 |
| 1973 | 353,040 | 6,969 | 19.7 |
| 1974 | 259,845 | 6,704 | 25.8 |
| 1975 | 145,295 | 4,632 | 31.9 |
| 1976 | 328,900 | 7,568 | 22.9 |
| 1977 | 324,608 | 9,537 | 29.4 |
| 1978 | 438,697 | 10,462 | 23.8 |
| 1979 | 506,853 | 15,794 | 31.2 |
| 1980 | 328,178 | 14,854 | 45.3 |
| 1981 | 396,759 | 21,877 | 55.1 |
| 1982 | 499,709 | 31,585 | 63.2 |
| 1983 | 362,772 | 24,342 | 67.1 |
| 1984 | - | 26,062 | - |
| 1985 | 446,197 | 25,158 | 56.4 |
| 1986 | 454,657 | 24,267 | 53.4 |
| 1987 | 449,293 | 11,782 | 26.2 |
| 1988 | 528,844 | 12,355 | 23.4 |
| 1989 | 356,442 | 7,882 | 22.1 |
| 1990 | 254,578 | 6,950 | 27.3 |

The sampling of catches at sea shows a slight increase in average size from 1989 to 1990, and a significant drop (from 37% to 17%) in the percentage of recently molted crab. The percentage of egg-bearing females remained high, at approximately 98.5%.

The Nephrops trawl survey conducted in 1988 showed an abundance of immature crab from 39 mm to 42 mm in width (Figure 1). The 1989 and 1990 surveys show an increase in this group of crab, which ranged from 54 mm to 57 mm in width in 1989 and from 66 mm to 69 mm in 1990. If the increase in size continues at the same rate and if the crabs do not reach maturity, and thus do not complete their terminal molt before reaching legal size, it could be expected that this group of crab will begin to reach legal size and to recruit to the fishery in 1992. The results of trawl surveys are presented below:

| | Biomass[1] | | |
|---|---|---|---|
| | Lower Limit | Mean | Upper Limit |
| 1989 | 5,041 | 8,676 | 12,311 |
| 1990 | 10,134 | 21,748 | 33,362 |
| 1991 | 11,042 | 23,444 | 35,846 |

[1]The biomass is estimated for the fishing season following the survey.

The study of the biomass contours drawn using data taken from the trawl surveys makes it possible to monitor the progression in recruitment and the changes in exploitation from 1988 to 1990 (Figure 2). After the 1988 season, very few commercial hard-shelled crab remained. The situation gradually improved

in 1989 and 1990, although the concentration of fishing effort in Baie des Chaleurs in 1990 seems to have caused a decline in the stocks in this region. The results also show an increase in the stocks and distribution of pre-recruits over 56 mm in width (Figure 3). The increase in white crab biomass is another indication of the rebuilding of crab stocks in the southwestern Gulf of St. Lawrence, since it suggests an increase in recruitment. However, the increase in recruitment is also likely to result in an increase in the incidence of newly molted crab in the catches in 1991. CAFSAC is of the view that the protection given to white crab in 1990 had a positive impact on the stock and should be continued in 1991.

The TAC for 1990, corresponded to an exploitation rate of approximately 32% when the catch was compared to the best estimate of available biomass, the average value of the trawl survey. CAFSAC is of the view that continuing the exploitation of crab in the southwestern Gulf of St. Lawrence at a rate of 32%, that is a TAC of 7,500 t in 1991, would make it possible to continue the rapid rebuilding of this stock. However, on the basis of the assessment of pre-recruits, CAFSAC feels that an exploitation rate of around 50% corresponding roughly to catches of 11,700 t, would not significantly slow down the rebuilding of the crab stock in the southwestern Gulf since good recruitment is anticipated for 1992. However, CAFSAC notes that there are no snow crab smaller than 40 mm carapace width in the 1990 survey. This observation suggests that the increase in commercial size biomass that is expected for the next few years may be short lived.

North coast of Gaspé

The 1990 survey was extended to estimate the biomass along the northern shore of the Gaspé peninsula. The biomass of snow crab larger than 95 mm carapace width is estimated at about 95 tons, plus or minus 92 tons. The distribution of commercial size (Figure 4) as well as smaller (Figure 5) snow crab suggest restricted areas of distribution. CAFSAC was not able to ascertain if snow crab in this area belong to the downstream 4T stock or to the upstream estuary stock. The recaptures in 1991 of snow crab tagged in 1990 may help clarify the links of snow crab in this area with neighbouring management units.

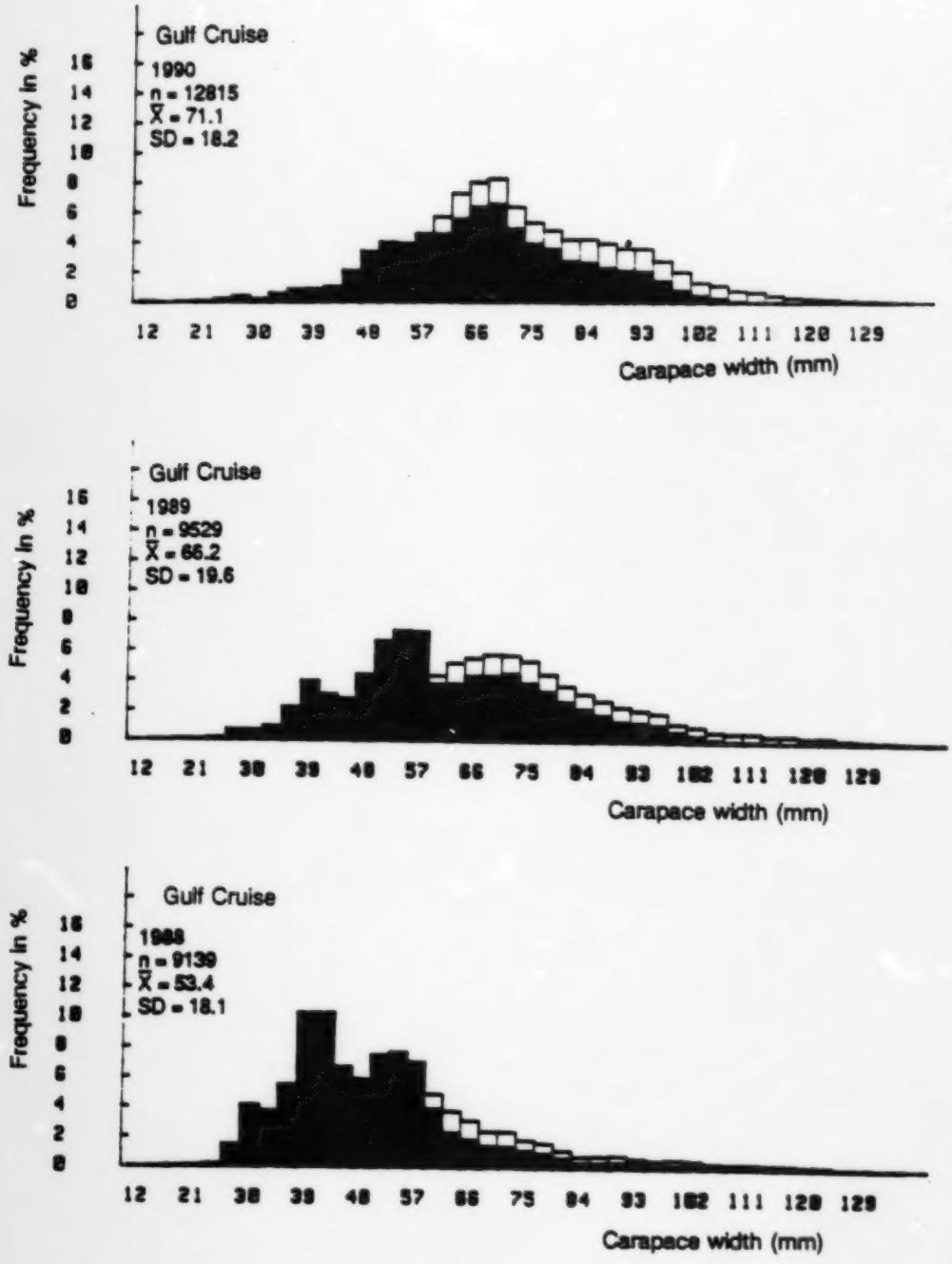



Figure 1. Size distribution of male snow crab from the research vessel trawl surveys conducted after the fishing seasons of 1988, 1989 and 1990 in the southwestern Gulf of St. Lawrence.

White bars: total male crab
Black bars: immature crab

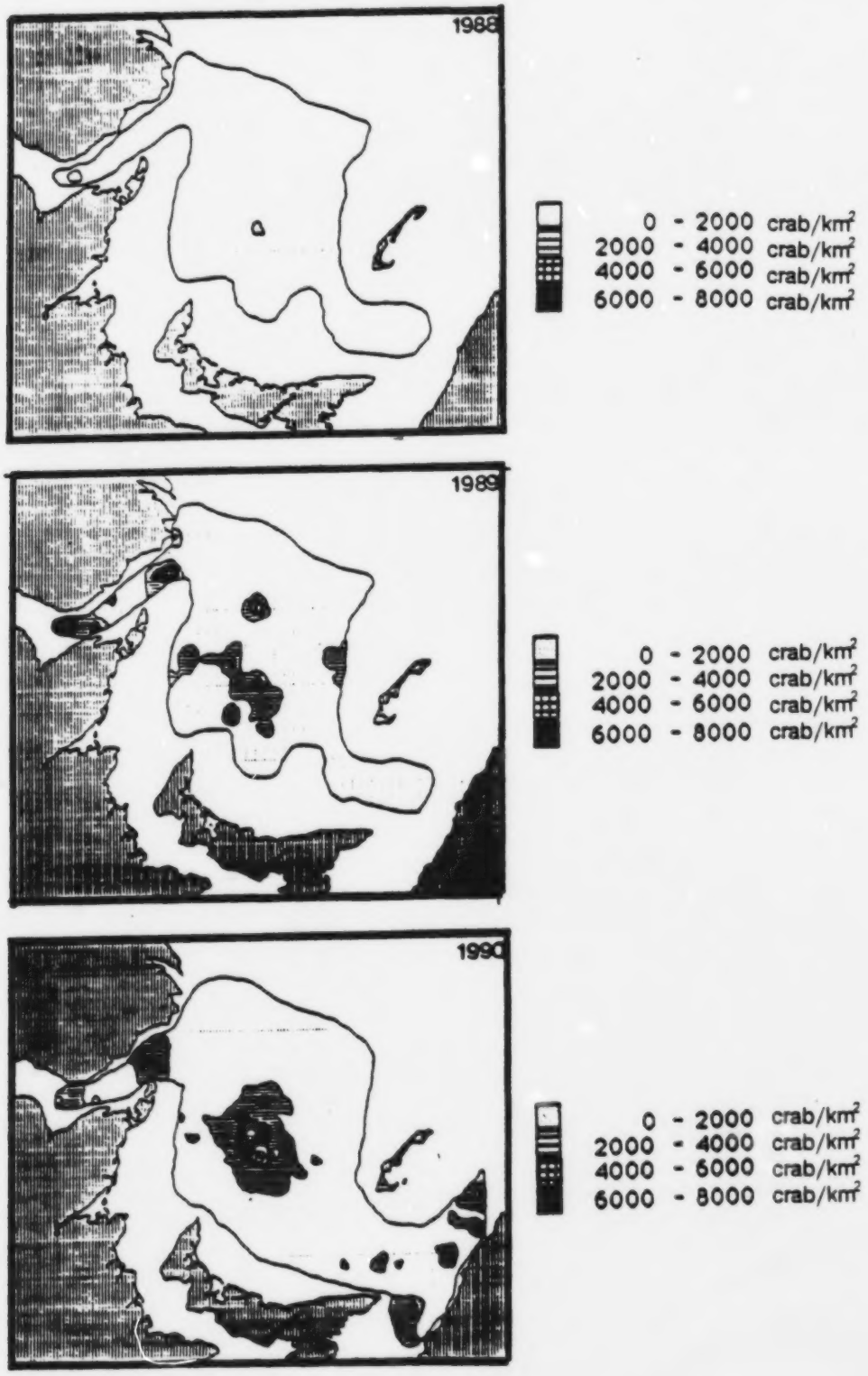



Figure 2. Density contours calculated by kriging for mature male snow crab ≥ 95 mm carapace width.

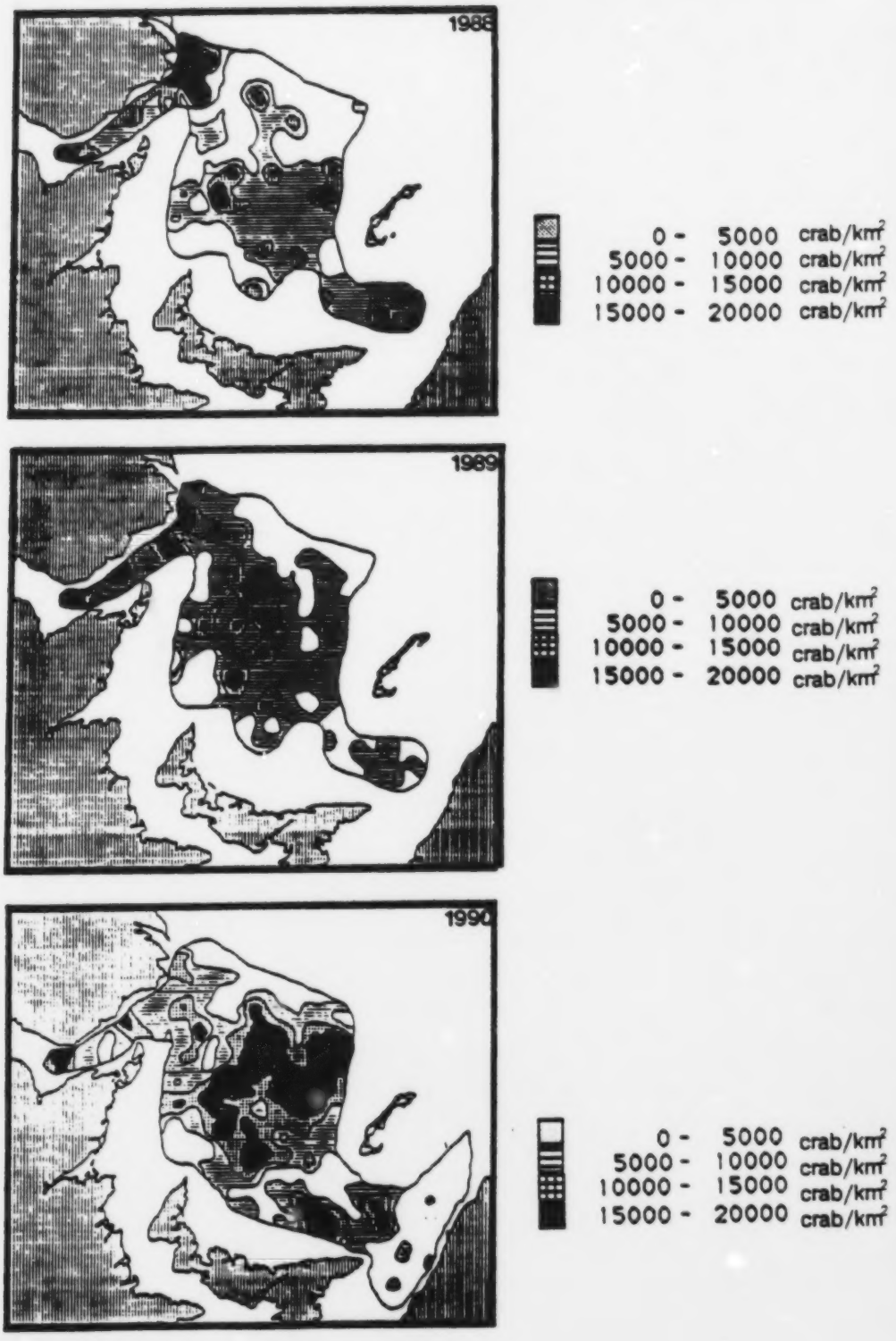



Figure 3. Density contours calculated by kriging for immature male snow crab ≥ 56 mm carapace width.

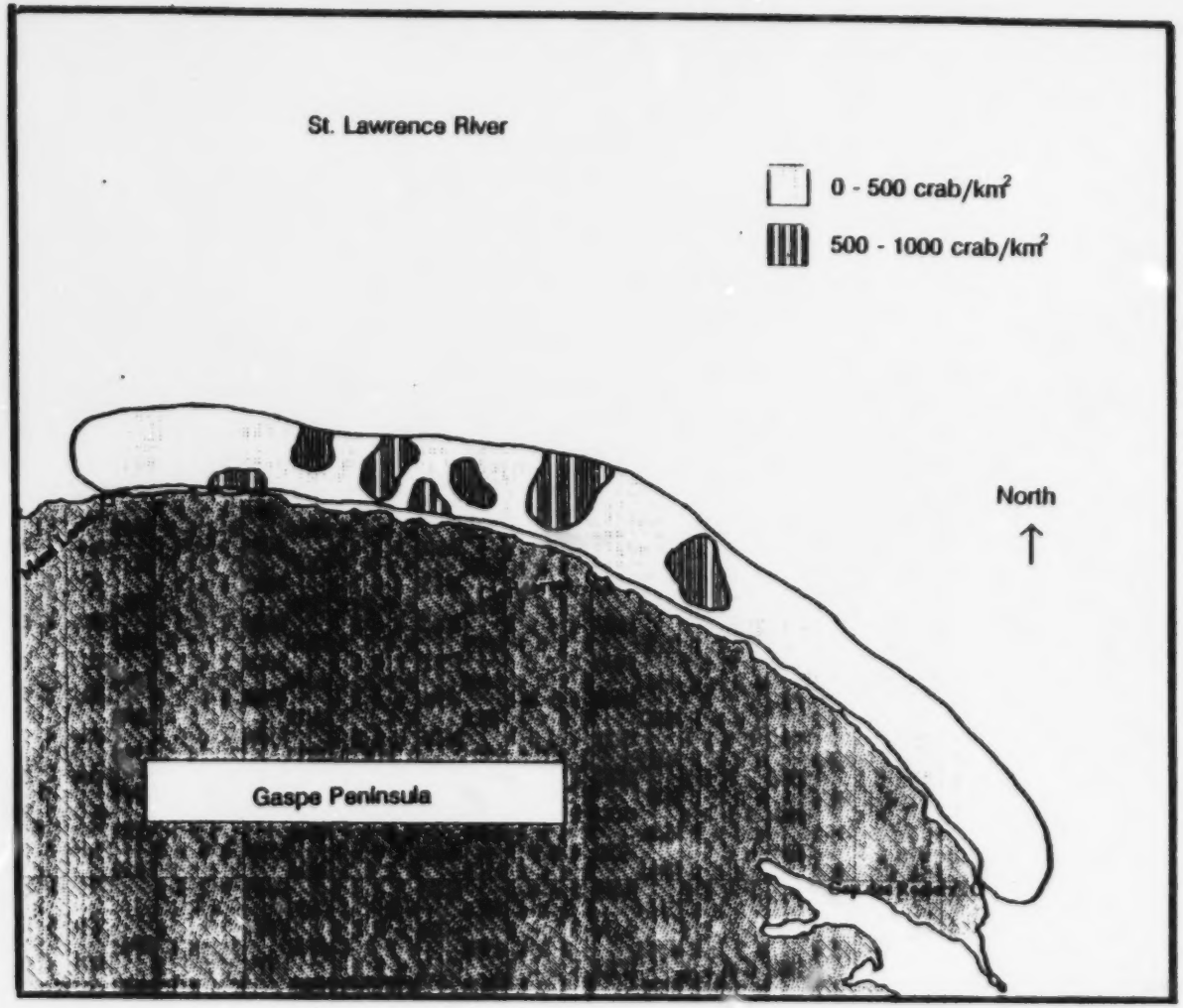



Figure 4. Density contours calculated by kriging for mature male crabs $\geq$ 95 mm (carapace width).

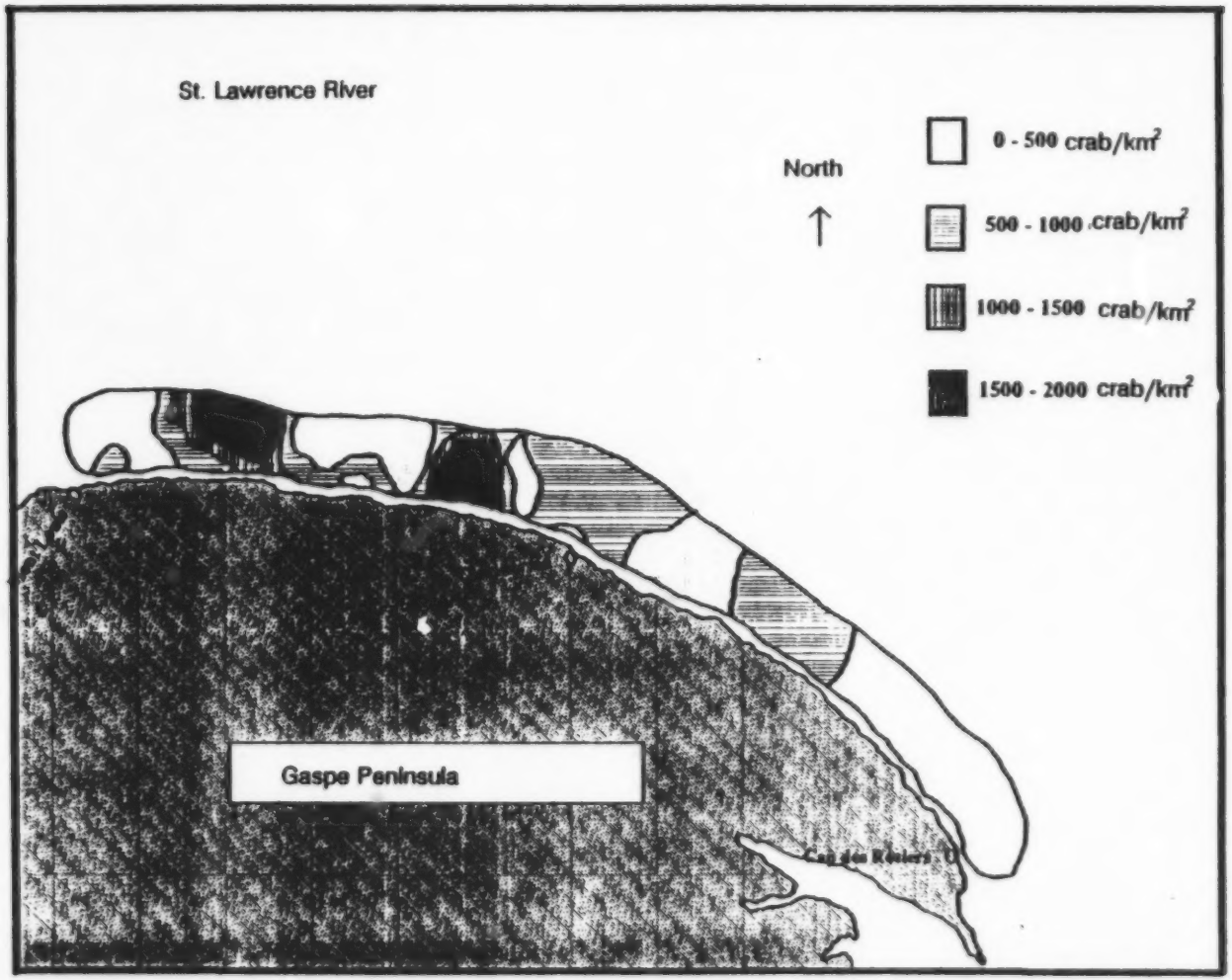



Figure 5. Density contours calculated by kriging for immature male crab > 56 mm (carapace width).

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## COD IN SUBDIVISION 3Ps

### Description of the Fishery

Since 1960, nominal catches peaked in 1961 at 84,000 t and reached their lowest level in 1978 at 27,000 t (Fig. 1). Only Canada and France have participated in the fishery since 1977 and their catches have increased gradually to a high of 57,000 t in 1986 mostly because of increased French catches. Catches have declined since to 38,000 t in 1989 as a result of lower French catches. The largest portion of Canadian catches have traditionally been taken by fixed gear, with line trawl catches which were predominant in the early 1980s, being progressively replaced by gillnet catches. Trap catches increased from 1981 to 1987, declined sharply in 1988 but increased substantially in 1989. Canadian offshore otter trawl catches since 1977 have fluctuated between 2,700 t in 1984 and 7,700 t in 1985, decreasing to 3,800 t in 1989. The French fishery is prosecuted by a Metropolitan France large freezer trawler fleet, by a St. Pierre and Miquelon fleet of somewhat smaller trawlers and by an inshore fishery. During the early 1980s, the Metropolitan fleet increased its share of the catches, taking 12,000 t in 1986 but it has been progressively withdrawn in more recent years, catching only 900 t in 1989. Catches by the French inshore fleet have declined from 1,000 t in 1982 to about 300 t in 1988 and 1989 while offshore catches of St. Pierre and Miquelon trawlers became predominant, catching about 10,000 t in 1989.

The TACs for this stock have been set by Canada since 1977 with a quota for France, but after 1982 and with the exception of 1986, the EC, or France itself, has also set a quota for France. Catches and TACs for 1984 to 1989:

| | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|
| Canadian TAC | 33 | 41 | 41 | 41 | 41 | 35.4 | 35.4 |
| Effective TAC[1] | 35.8 | 44.6 | 41[2] | 60.6 | 60.6 | 50 | 45 |
| Catch | 37 | 51 | 57 | 57 | 43[3] | 38[3] | |

[1]Effective TAC is obtained by combining the TAC established by Canada and the French quota established by EC-France or France less the quota allocated to France by Canada.
[2]No unilateral quota set by France or EC
[3]Provisional data.

The majority of the 1989 catch by numbers was comprised of ages 4 to 7 for the Canadian catch and ages 4 to 6 for the French catch. The 1984 and 1985 year-classes which were respectively ages 5 and 4 in 1989 were predominant in both fisheries. The Canadian offshore fleet however caught mostly ages 7 to 9 in 1989 compared to ages 5 to 7 in previous years. Because of the location of the 1989 Canadian otter trawl fishery to the east of the usual area, CAFSAC is concerned that some of the catches may be of cod from the divisions 3NO stock instead of 3Ps.

## Abundance Indices

### *Commercial catch and effort data*

The age composition of the Canadian offshore otter trawl catches is different from that of St. Pierre and Miquelon otter trawl catches. Consequently, the catch rate of each fleet is considered as a distinct index of stock size and multiplicative analyses of catch and effort were conducted for each fleet separately. The Canadian catch rate increased four-fold from 1980 to 1985 (Fig. 2), declined by 50% in 1986 and has remained relatively stable since. As suggested above when describing the age composition of the catch, CAFSAC is concerned that the 1989 Canadian catch rate may represent 3NO cod abundance rather than that of 3Ps. Catch rates for the St. Pierre and Miquelon (Fig. 3) trawlers show less variation from year to year although they increased two-fold between 1980 and 1985 and then declined rapidly to the lowest values since 1978 in 1988 and 1989.

### *Research vessel survey data*

Stratified-random surveys have been conducted in Subdiv. 3Ps by France since 1978 and by Canada since 1972. The fishing gears used in the two series were different and the French surveys fished only during daylight hours; however, the stratification scheme, method of sampling, and analyses of results have been the same. The Canadian surveys have covered strata in depth ranges to 300 fm since 1980, while similar coverage by French surveys occurred only in 1981, 1983, and 1990. Canadian surveys were conducted between February and March since 1985, but in previous years, were conducted in months ranging from January to June and appropriate adjustments have been made to take this into account.

Results from both surveys are highly variable. The Canadian survey (Fig. 4) showed no clear trend from 1978 to 1984, subsequently increased to 85,000 t in 1988 followed by a decline to about 45,000 t in both 1989 and 1990. The French survey (Fig. 4) results show an irregular increase from about 10,000 t in 1978 to 140,000 t in 1986 followed by a decline to about 40,000 t in 1989-1990. Both surveys showed unusual fish distribution in 1990 with a large proportion of the biomass in the 200 to 300 fathoms depth range. This may have resulted in overestimating the biomass from the Canadian survey in 1990 because the catches were not equally distributed throughout the depth range of that stratum. In contrast, because the deeper strata have rarely been sampled in the French surveys, the results from these strata for 1990 could not be used which led to an underestimate of the biomass for 1990 from that source of information.

## Assessment

The Canadian and French survey results, as well as the St. Pierre and Miquelon otter trawler catch rate were used to calibrate the sequential population analyses with ADAPT. The Canadian catch rate index was not used in the calibration because of the anomaly in the 1989 age-composition described above.

*Fishing mortality and stock abundance*

The results of the analysis indicated that fully recruited fishing mortality in 1989 was approximately 0.35, substantially less than the levels (0.51 rising to 0.65) in the preceding four years (Fig. 5). The age 3+ population biomass at the beginning of 1989 was about 174,000 t (Fig. 6). The 1985 and 1986 year-classes comprised about 50% of the age 3+ biomass in 1989. The age 6+ biomass in 1989 is the lowest observed since 1979 and was among the lowest in the 31- year (1959-89) series (Fig. 6). This reflects the presence of the weak 1983 year-class which is estimated to have numbered only 27 million at age 3. The 1984 and 1985 year-classes are estimated at 42 and 73 million (Fig. 7).

The calibration estimated the 1986 year-class to be the largest observed. However because the value was outside of the observed range, the size of the 1986 year-class was set at the previously largest observed during 1978-1988, that is 75 million cod at age 3.

Forecast

The parameters used for the projection of the 1991 catch are as follows:

| Age | January 1990 Pop. numbers (000) | Average Weight at (1987-1989) (kg) | Partial Recruitment |
|---|---|---|---|
| 3 | 50,000 | 0.60 | 0.02 |
| 4 | 60,395 | 0.79 | 0.30 |
| 5 | 39,783 | 1.15 | 0.71 |
| 6 | 12,140 | 1.71 | 0.92 |
| 7 | 4,122 | 2.35 | 1.00 |
| 8 | 3,243 | 3.18 | 1.00 |
| 9 | 2,478 | 4.05 | 1.00 |
| 10 | 1,372 | 5.15 | 0.51 |
| 11 | 650 | 6.08 | 0.45 |
| 12 | 469 | 7.14 | 0.28 |
| 13 | 492 | 7.61 | 0.27 |
| 14 | 260 | 8.59 | 0.20 |
| 15 | 344 | 12.08 | 0.20 |
| 16 | | 13.74 | 0.20 |

The weights at age are averages for the 1987-89 period. The partial recruitment was obtained from an average of fishing mortalities over the 1985-89 period with full recruitment at ages 7-9 years. Natural mortality was assumed to be 0.20. The 1987 and 1988 year-classes at age 3 in 1990 and 1991 were assumed to be 50 million fish, approximately the geometric mean for the 1978-88 period.

Projections for 1991 were completed assuming a catch of 35,000 t for 1990, a likely catch given the 1990 preliminary information to the end of August. These estimates suggest that the fixed gear catch was about 5000 t less than that for the same period in 1989. The catch of 35,000 t in 1990 will generate a fishing mortality on fully recruited ages (7-9) of 0.40.

Projections of catch and beginning of the year biomass for a number of options for 1991 are provided:

(1) $F_{0.1}$ F=0.27
(2) 50% rule F=0.34
(3) Catch in 1991 so that Jan. 1, 1992 biomass = Jan. 1, 1991 biomass
(4) Maintenance of Canadian 1990 TAC in 1991, plus provision for French unilateral quota.

| Option | F in 1991 | Catch in 1991 (000 t) | Biomass (000 t) Jan. 1, 1991 | Jan. 1, 1992 |
|---|---|---|---|---|
| 1 | 0.27 | 29 | 186 | 201 |
| 2 | 0.34 | 35 | 186 | 194 |
| 3 | 0.43 | 43 | 186 | 186 |
| 4 | 0.45 | 44.5 | 186 | 184 |

Preliminary reports indicate that the catch of the Canadian fixed gear sector in 1990 will be less than 1989, reflecting the weak 1983 and 1984 year-classes, which would normally dominate the catches for the major fixed gears. The current assessment estimates the size of the 1985 and 1986 year-classes to be among the largest in recent years. During 1991, these fish will be 5 and 6 years old and should constitute a substantial portion of the catch of these fixed gear fisheries.

In 1991, if the French unilateral quota of 14,600 t is taken into account, holding the catch at the $F_{0.1}$ reference or applying the 50% rule would imply a decreased quota for Canada. This would also reduce the proportion allocated to Canada compared to earlier years. Preserving the Canadian TAC and traditional harvest share (29,875 t) would result in a 1991 total allocation of 44,475 t, a level that would generate a fully recruited fishing mortality marginally below twice $F_{0.1}$. CAFSAC concludes that if 44,475 t were taken in 1991, the impact on the population biomass would be minimal, decreasing by only 1% from 1991 to 1992.

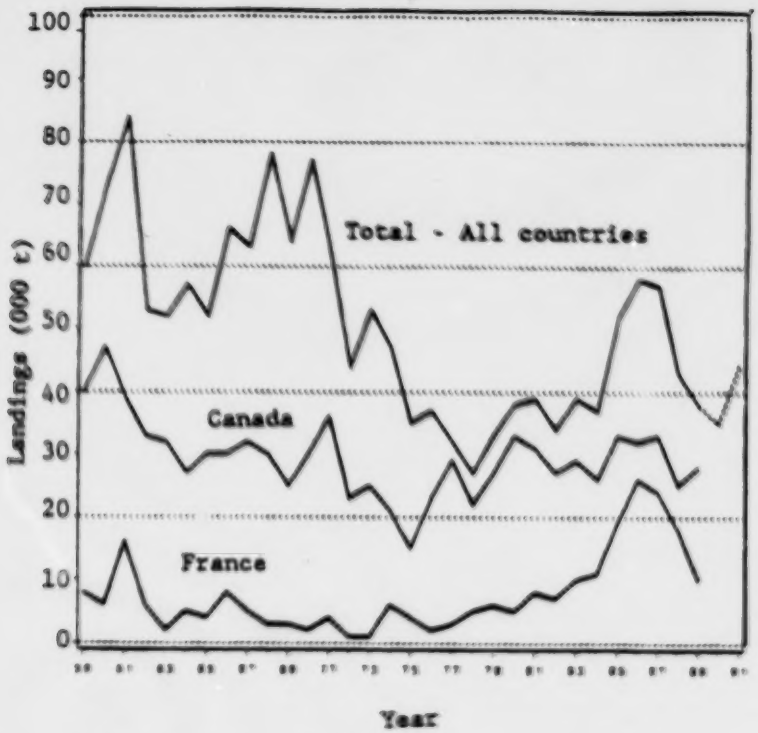



Fig. 1. Landings of cod in Subdiv. 3Ps for Canada and France for the years 1959-91.

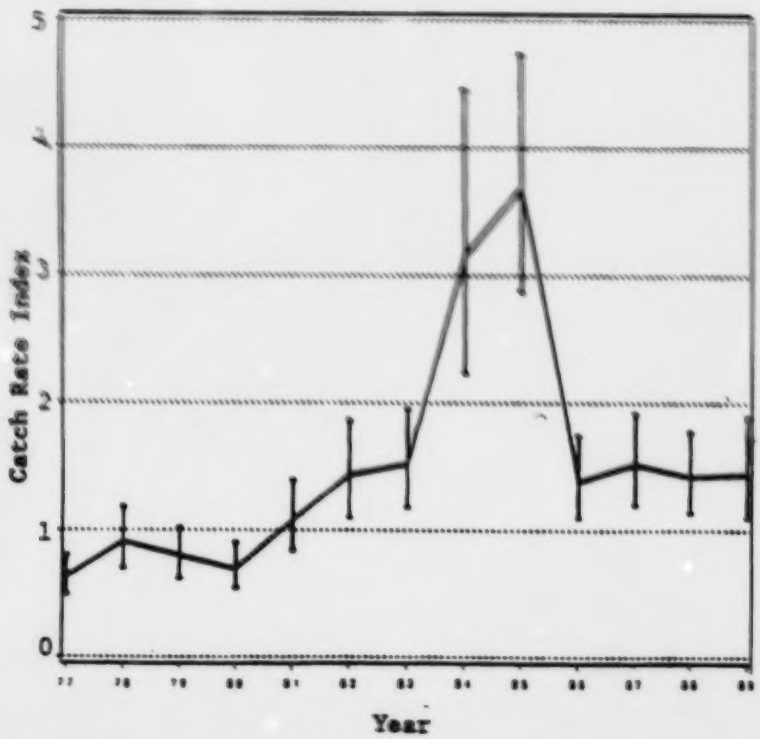



Fig. 2. Canadian catch rate index with approximate 90% CI for Subdiv. 3Ps cod (1973-89).

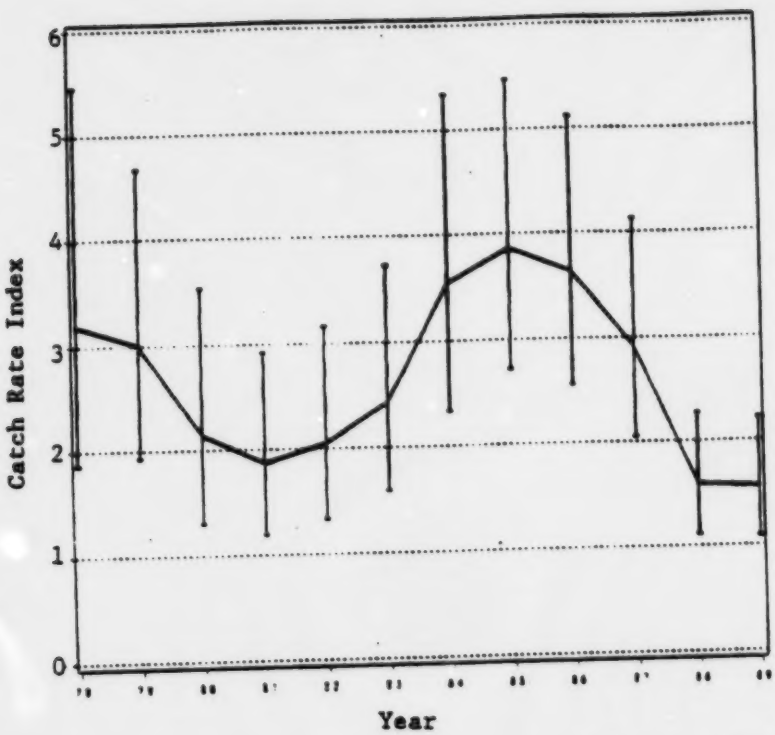



Fig. 3. French catch rate index with approximate 90%CI for Subdiv. 3Ps cod (1978-89).

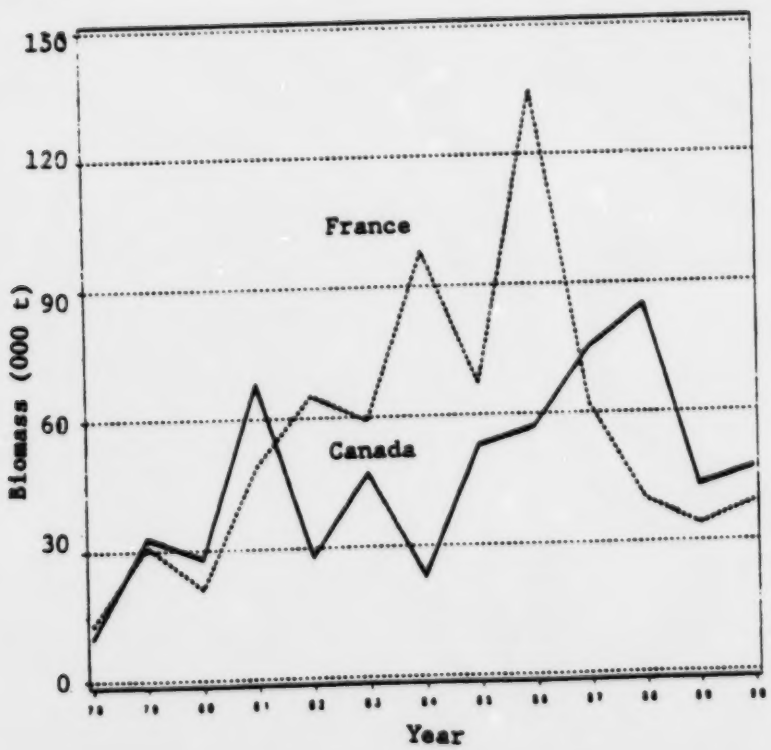



Fig. 4. Research vessel biomass from Canadian and French surveys (1978-1990).

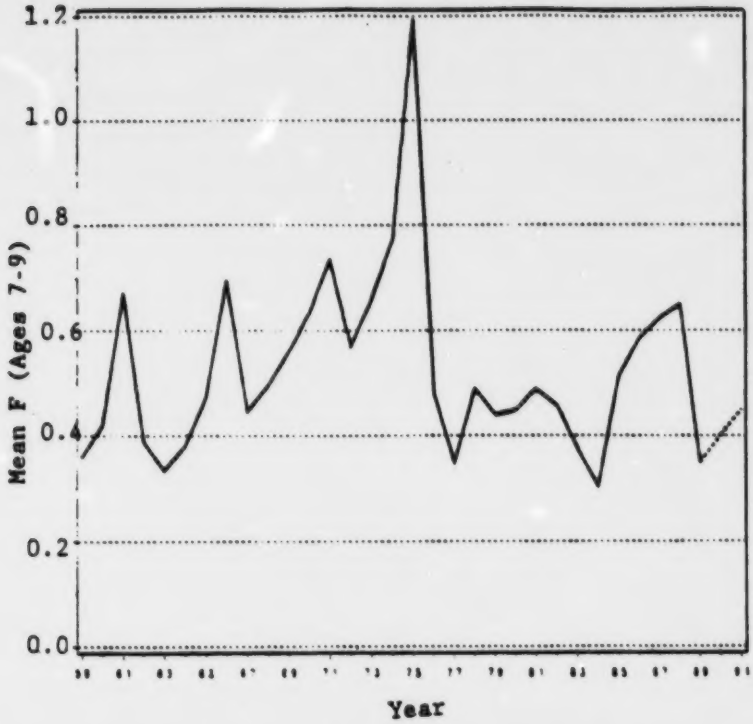



Fig. 5. Mean fishing mortalities at ages 7-9 weighted by population numbers for cod in Subdiv. 3Ps.

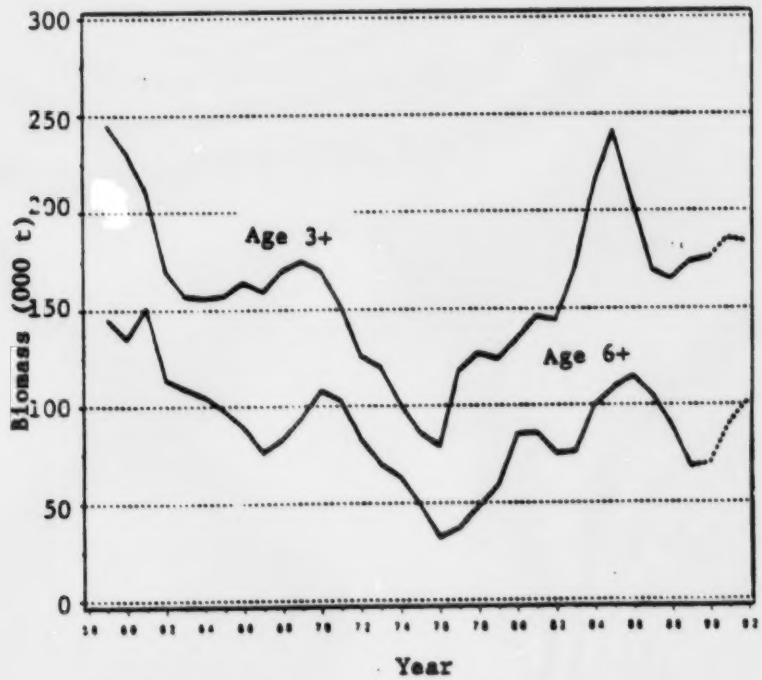



Fig. 6. Beginning year population biomass (ages 3+ and 6+) for cod in Subdiv. 3Ps (1959-92).

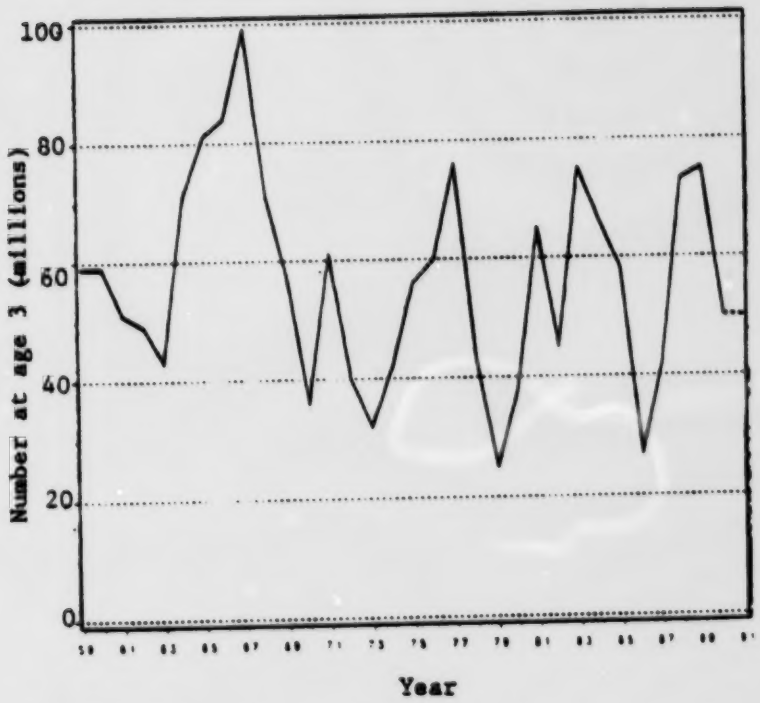



Fig. 7. Recruitment at age 3 for cod in Subdiv. 3Ps.

Government of Canada / Gouvernement du Canada — MEMORANDUM — NOTE DE SERVICE

To: / A: C.W. Shinners -ADM Atlantic
L. Tousignant - A/ADM Science

From: / De: J.-J. Maguire
Chairperson CAFSAC

| Classification de Sécurité |
|---|
| Notre Référence: |
| Votre Référence: |
| Date: 1990/3/29 |

Subject: / Objet: The Arctic Charr Fisheries in 1990

In recent years, CAFSAC has provided assessments for the above fisheries in the form of advisory documents, while the detailed information was presented in research documents. These fisheries are amongst the most important anadromous charr fisheries in the world but they are small compared to most other finfish or shellfish fisheries along the Atlantic coast several of which are not the subject of CAFSAC advisory documents for their management. In addition, recent analyses suggest that significant methodological and data improvements would be required to justify changes in current management measures. CAFSAC, therefore, is presenting the most recent information in a memorandum instead of an advisory document. This means that the information is available more rapidly and it results in a less cumbersome process. The detailed information on the 1989 fishery will be made available in the research document series, however, an advisory document can be produced if you so desire.

The attached Figure 1 shows the total catches since 1944 for the Labrador coast as well as the contribution of the Nain and Makkovik Fishing Regions. Catches show large fluctuations, from 20t in 1944 and a maximum of 252t in 1981. The total catches have since declined to 89 t in 1988 and 100 t in 1989. The biggest decline in catches occurred in the Nain Fishing Region and it was paralleled with a decrease in the number of fishers. The high catches in the early 1980s in the Nain Fishing Region were the result of fishing in the northern fjords where generally little fishing activity has been observed in the second part of the 1980s.

Indices of abundance have been compiled for the three assessment units in the Nain Fishing Region and the results are shown in the attached Figure 2. The indices for the Nain and Okak assessment units are based on both offshore and inshore fisheries with offshore referring to the outer coastal islands. The Voisey assessment unit is essentially an inshore fishery with fishing also extending along outer headland areas. As indicated in previous years, the inshore and offshore abundance indices have been combined despite the observation that the trends, especially in the Nain assessment unit, were in disagreement. The abundance indices suggest that stock abundance has been relatively stable or increasing in the Nain and Voisey assessment units while the index has regularly declined in the Okak assessment unit after

1986. The decline in the Okak unit may be the result of a change in selectivity linked to fishing effort being directed more towards Atlantic salmon in recent years and CAFSAC is therefore uncertain as to the interpretation of this decline.

CAFSAC attempted an analytical assessment for the Nain assessment unit without being able to calibrate the assessment successfully. There are indications, however, that recent fishing mortalities may be about F=0.40 and that the biomass is increasing. For the Voisey assessment unit, the abundance index suggests that the stock has either been stable or slightly increasing. For these two assessment units there are no indications that the current management measures should be changed.

J.-J. Maguire

cc. Steering Committee

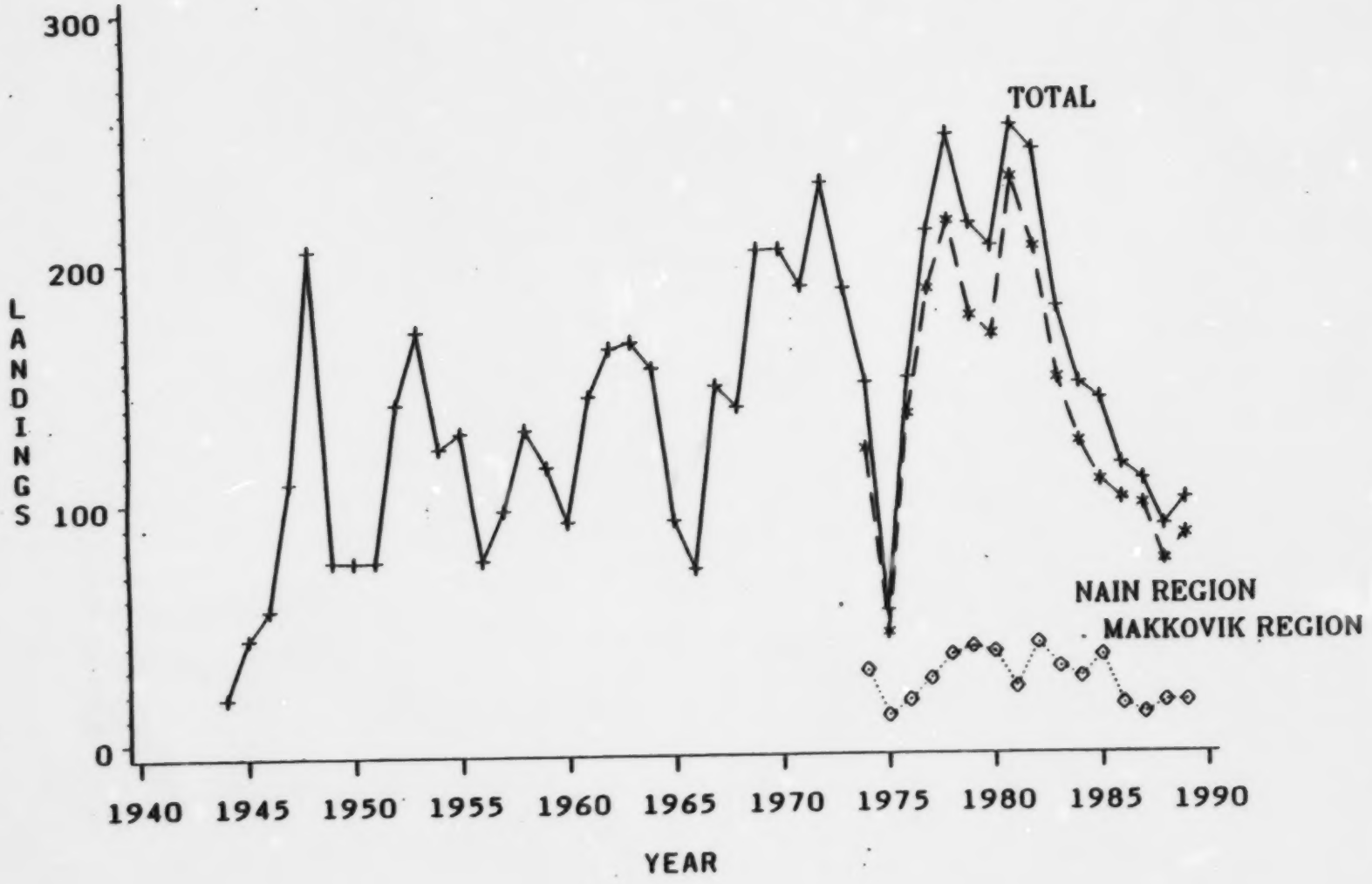
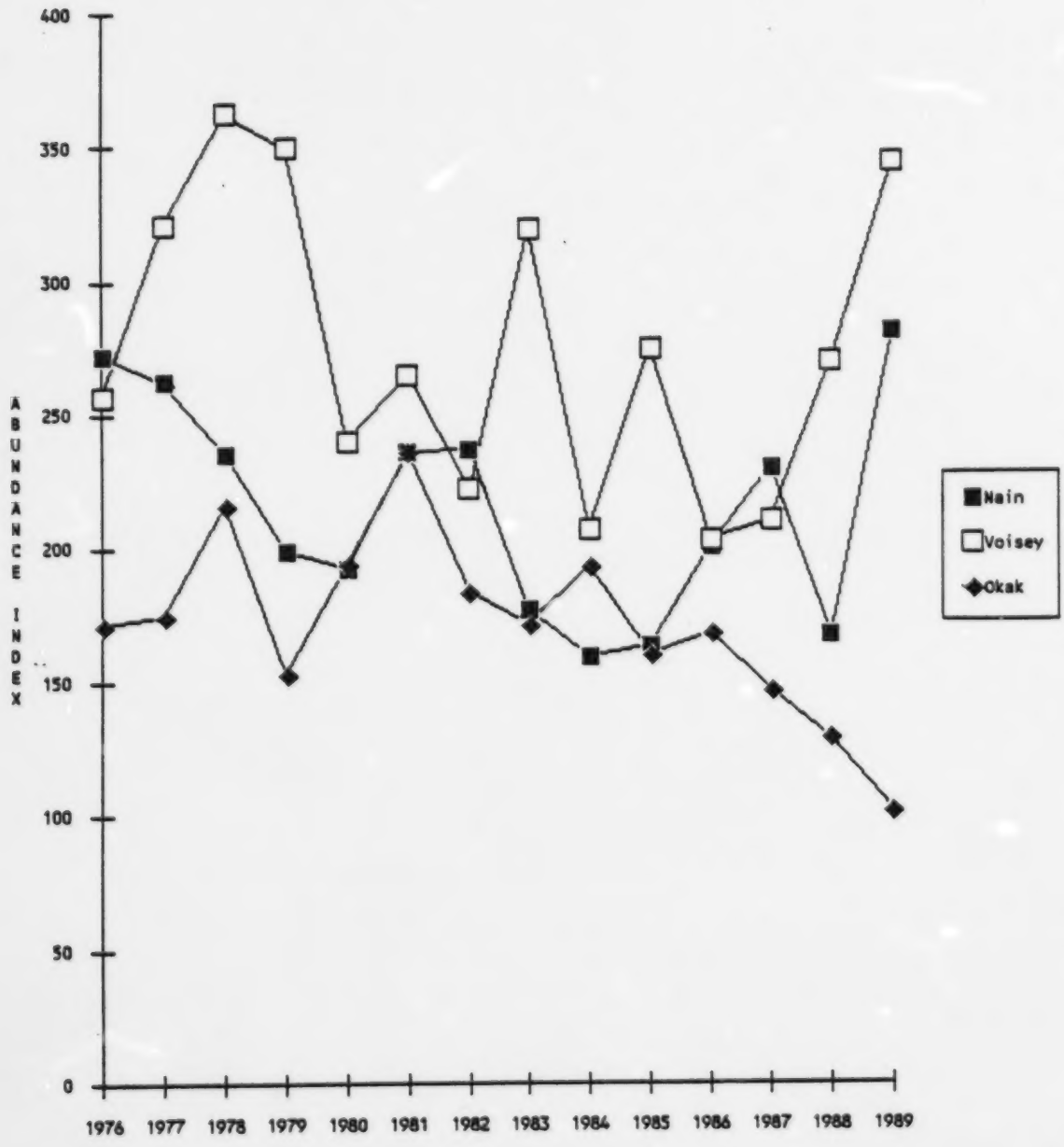



FIG. 1 SUMMARY OF NORTHERN LABRADOR ARCTIC CHARR LANDINGS (METRIC TONNES), 1944–1989

ARCTIC CHARR ABUNDANCE INDEX
FOR THE NAIN FISHING REGION



Government Canada | Gouvernement du Canada

MEMORANDUM | NOTE DE SERVICE

To: A: C.W. Shinners - ADM Atlantic

L. Tousignant - A/ADM Science

From: De: J.-J. Maguire
Chairperson CAFSAC

| Classification de Sécurité |
|---|
| Notre Référence: |
| Votre Référence: |
| Date: 1990/3/22 |

Subject: Objet: The Gaspareau Fisheries in 1990

In recent years, CAFSAC has provided assessments for the above fisheries in the form of advisory documents, while the detailed information was presented in research documents. These fisheries are small compared to most other finfish or shellfish fisheries along the Atlantic coast, several of which are not the subject of CAFSAC advisory documents for their management. In addition, recent analyses suggest that significant methodological and data improvements would be required to justify changes in current management measures. CAFSAC, therefore, is presenting the most recent information in a memorandum instead of an advisory document. This means that the information is available more rapidly and it results in a less cumbersome process. The detailed information on the 1989 fishery will be made available in the research document series, however, an advisory document can be produced if you so desire.

In assessments prior to the one conducted last year, CAFSAC used a natural mortality rate of M=0.20 to calculate stock size as well as target fishing mortalities based on yield-per-recruit analyses. Investigations reported in 1989 indicated that the mortality due to causes other than fishing in the rivers was substantial and that spawning mortality itself was high. The new instantaneous[1] mortality estimates were M=0.44 for new recruits and M=1.05 for previous spawners. These results put the current fishing mortality in a different perspective because new estimates of "natural mortality" imply the calculation of new target fishing mortalities.

Target fishing mortality, such as $F_{0.1}$, is calculated by estimating the catch weight that can be achieved under different fishing mortality scenarios when the growth of individual fish is known and estimates of the natural mortality rate are available. A universal result is that the higher

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[1] Instantaneous mortality rates are the proportion of the total population that dies during each very small period of time. If we take one day as a very small period, this would mean that M=1.05 implies that 1.05/365, that is 0.0000288% of the total population dies each day. Instantaneous rates are used mostly to facilitate the comparison between different sources of mortality.

the natural mortality, the higher the fishing mortality because we must fish harder to catch the fish before it dies of natural causes. Therefore, estimates of $F_{0.1}$ calculated using M=0.20 were about 0.41-0.47 while an estimate calculated with the new rate of natural mortality is about $F_{0.1}$=1.0. Current estimates of fishing mortalities are close to this value and the resources generally appear to be exploited at or slightly above the $F_{0.1}$ target level. CAFSAC, therefore, considers that the current management measures, especially the week-end closures, should be maintained to avoid allowing the fishing mortality to go above the $F_{0.1}$ target.

Because of these high fishing and natural mortality rates, few fish survive above about age 7 and the fisheries are essentially based on new recruitment each year. In addition, recruitment to these fisheries is highly variable and CAFSAC is presently unable to forecast recruitment. Therefore, although the current exploitation rate appears to be close to the target, CAFSAC is unable to forecast future catches because it is unable to predict incoming recruitment.

The Margaree fishery is essentially an alewife fishery while in the Miramichi, the species composition of the catch varies. In 1989, the catch was exclusively alewife before May 27, with proportions stabilizing at approximately 75% blueback after May 31. Catch information is available since 1950 for both rivers (attached Figure 1). Catches were generally high in the early to mid-50s, they were low in the sixties and increased in the mid to late 70s to current levels. The Miramichi fisheries caught more than 11,000t in 1952 while the maximum catch in the Margaree was almost 1800t in 1979. Since 1977, catches in the Margaree have averaged about 1200t while those in the Miramichi have averaged close to 1900t.

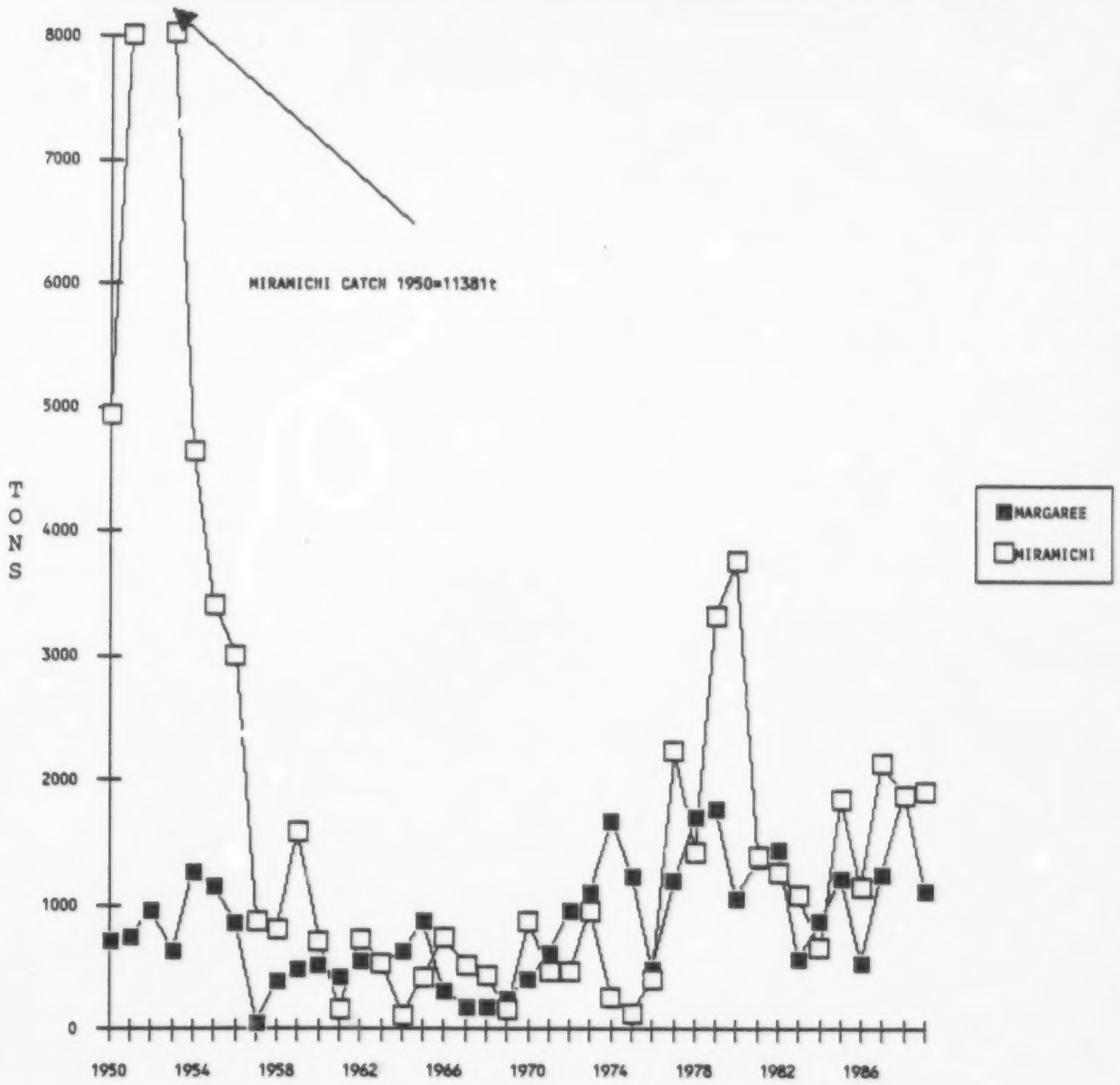
Analytical assessments based on sequential population analyses were attempted for the two rivers but it was impossible to calibrate the analyses satisfactorily, except for blueback in the Miramichi River. The results indicate that the exploitation rate of blueback herring in the Miramichi fisheries is substantially smaller than that of alewife. Indices of abundance (Figure 2) suggest that alewife abundance in the Margaree and blueback herring abundance in the Miramichi have generally been increasing after 1986 while alewife abundance in the Miramichi is almost at its lowest abundance since 1983.

The timing of the migration of each species in the Miramichi appears to be reasonably stable over the years. Considering that the exploitation rate on blueback herring in the Miramichi is lower than that for alewife, a one week delay in the opening of the fishery may allow catch to increase while resulting in a more equitable distribution of the exploitation on the two species.

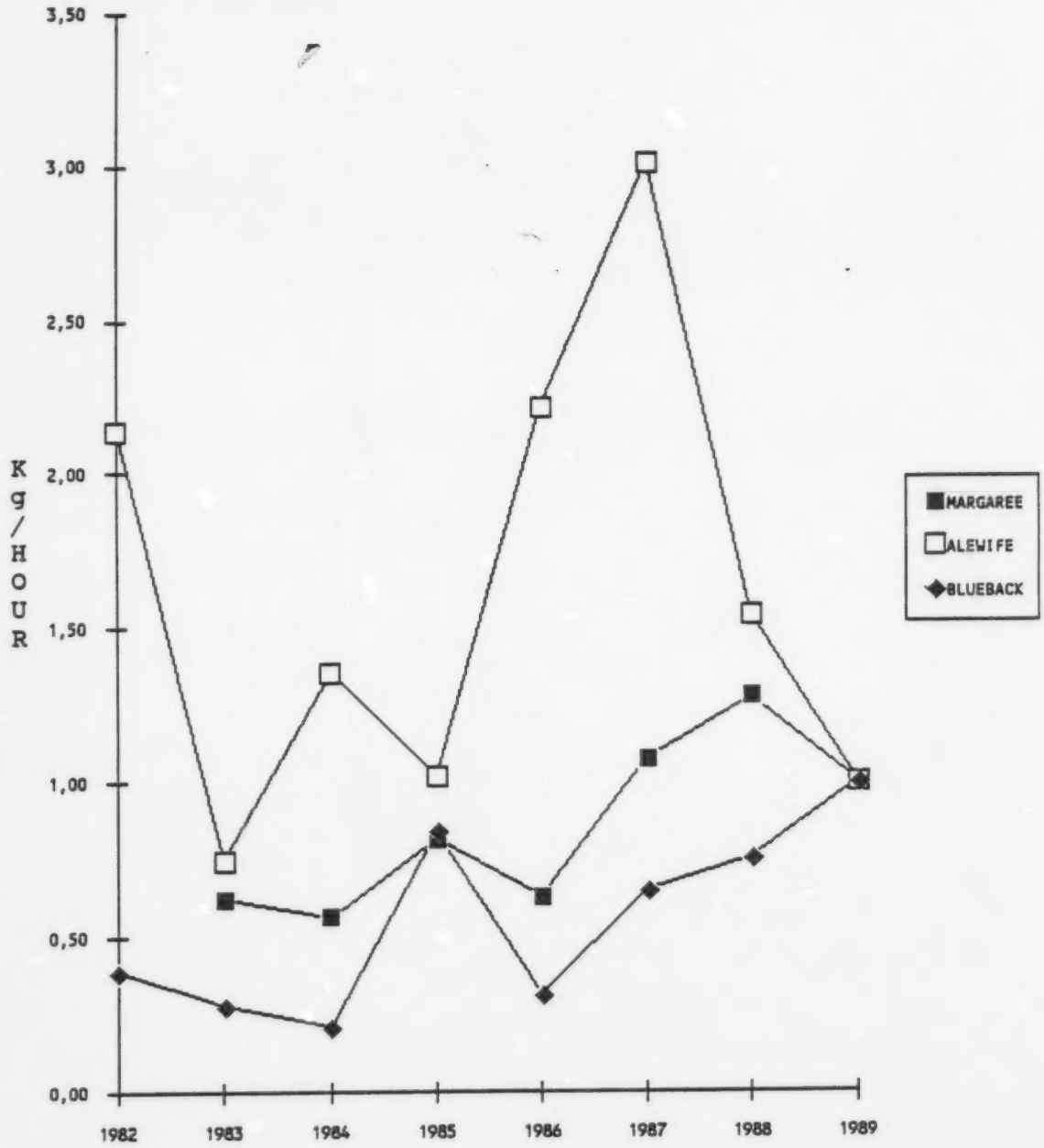
J.-J. Maguire

cc. Steering Committee

CATCHES IN THE MARGAREE AND MIRAMICHI GASPAREAU FISHERIES SINCE 1950 (IN TONS)



CATCH PER UNIT OF EFFORT IN THE GASPAREAU FISHERIES



## Section III

## Maps and abbreviations

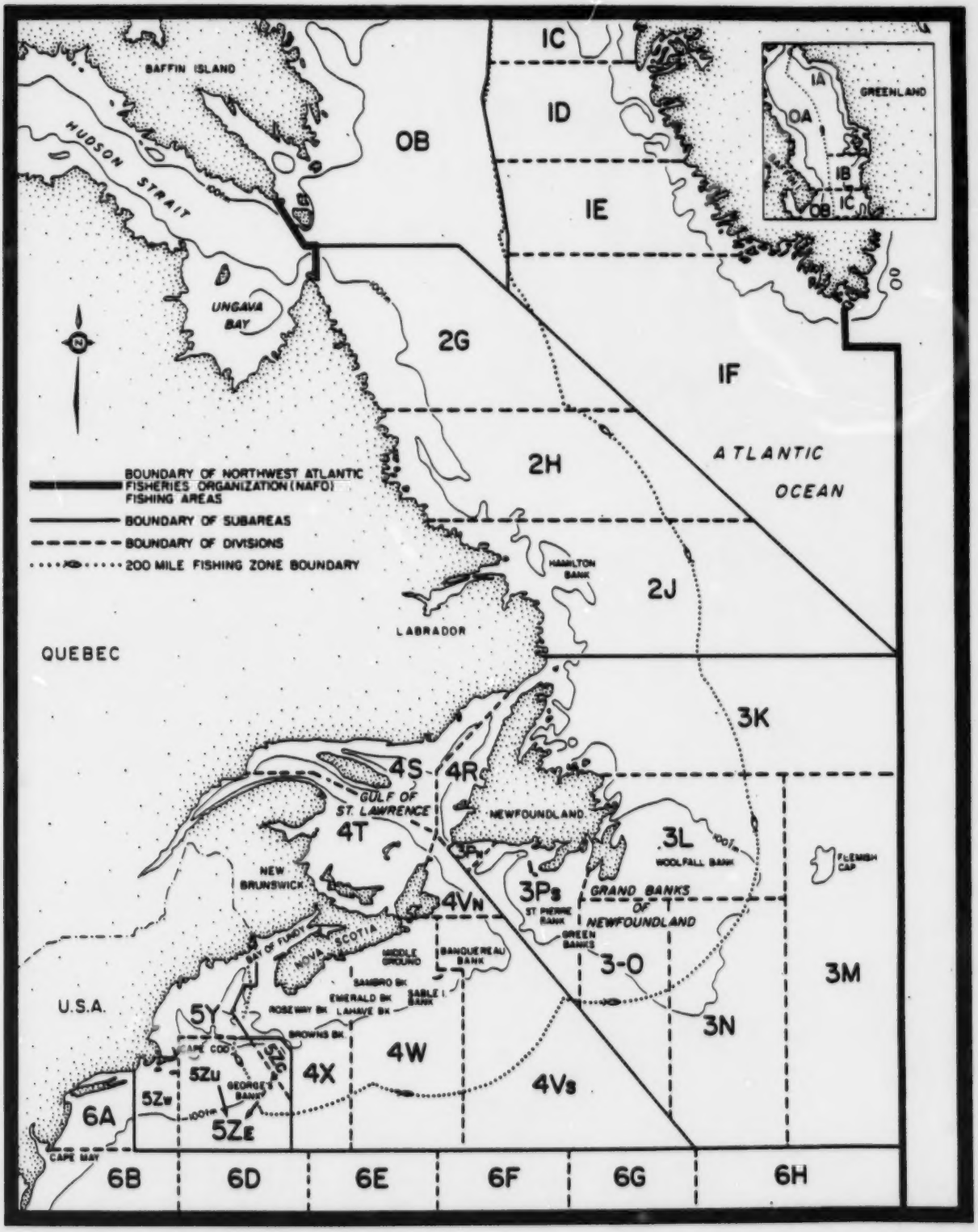



Figure 1. Subareas and divisions of the NAFO Convention Area and limits of Canadian fishing zones (east coast). Includes modifications to Subdivision 5Ze to take into account the Canadian side of 5Ze (5Zc) and USA side of 5Ze (5Zu).

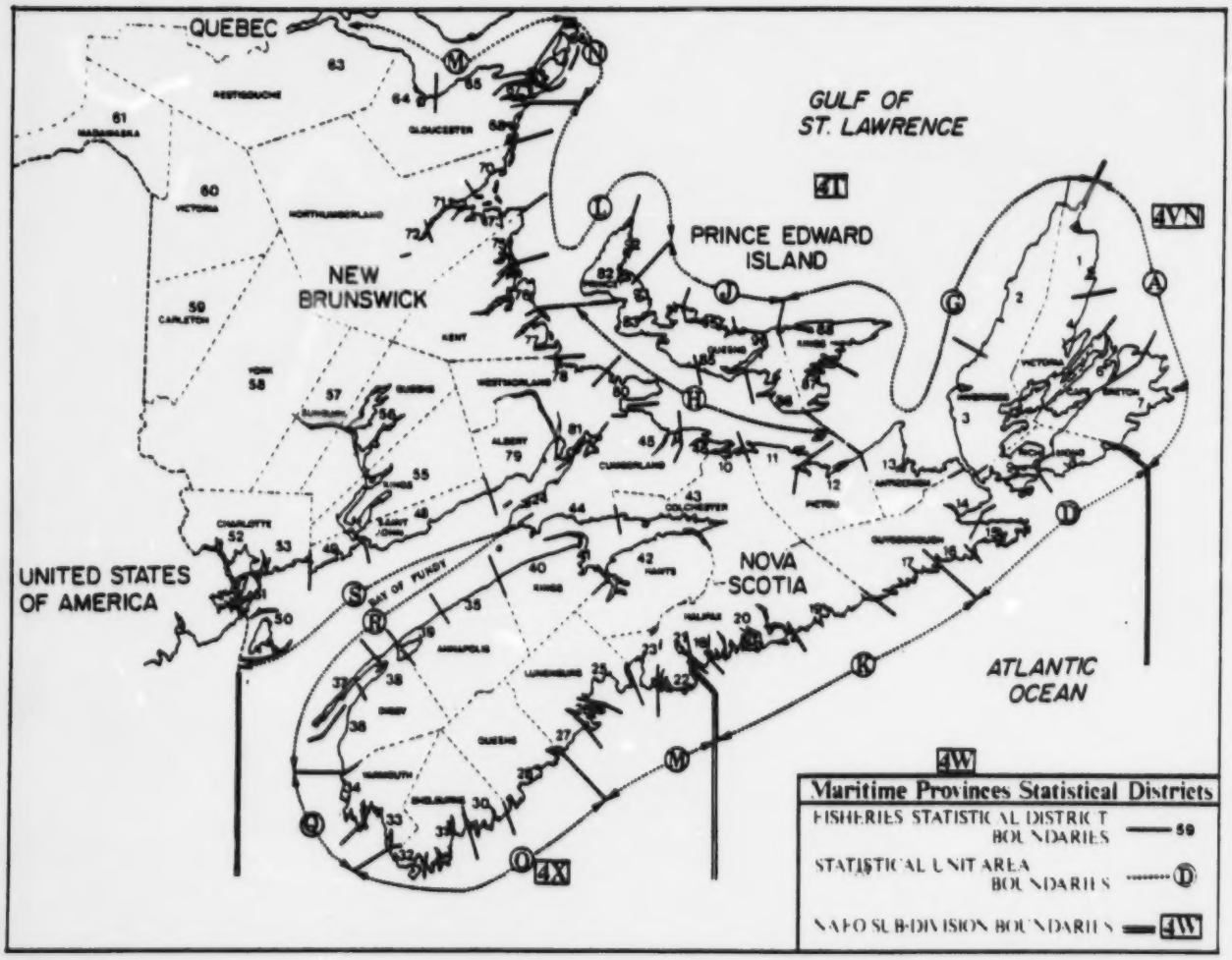



Figure 2. Maritime Provinces Statistical Districts

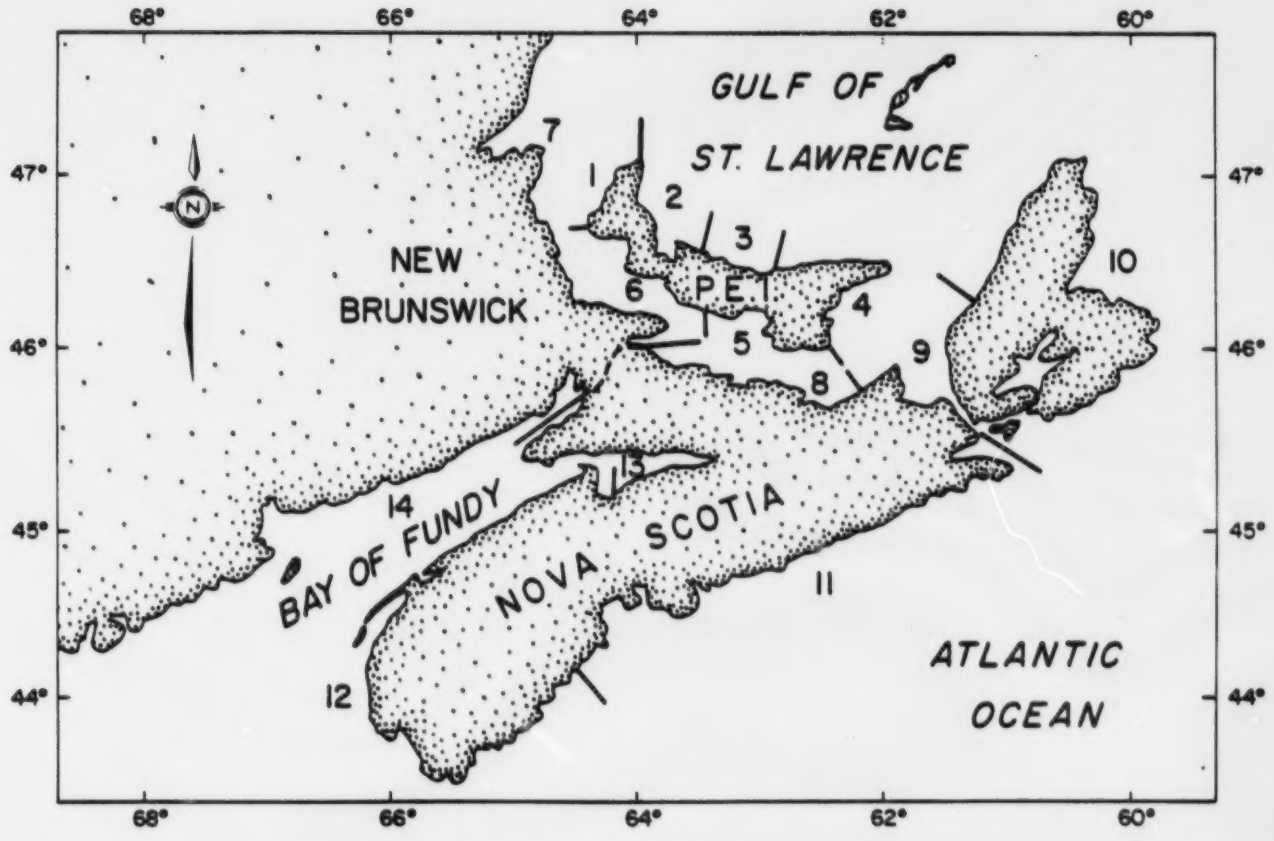



Figure 3. Maritime provinces Marine Plant Districts.

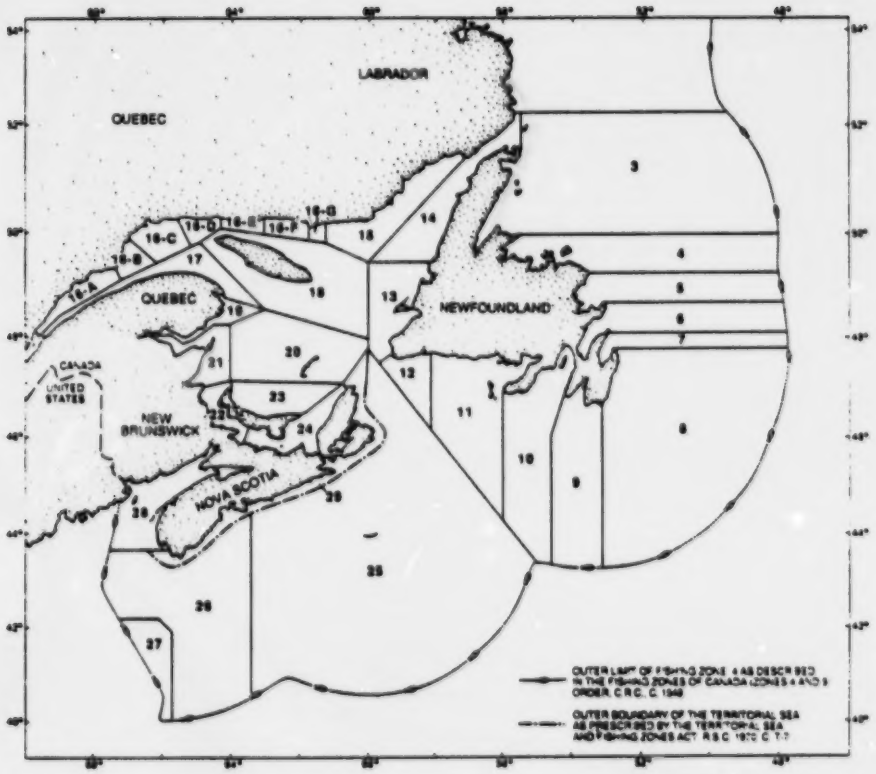
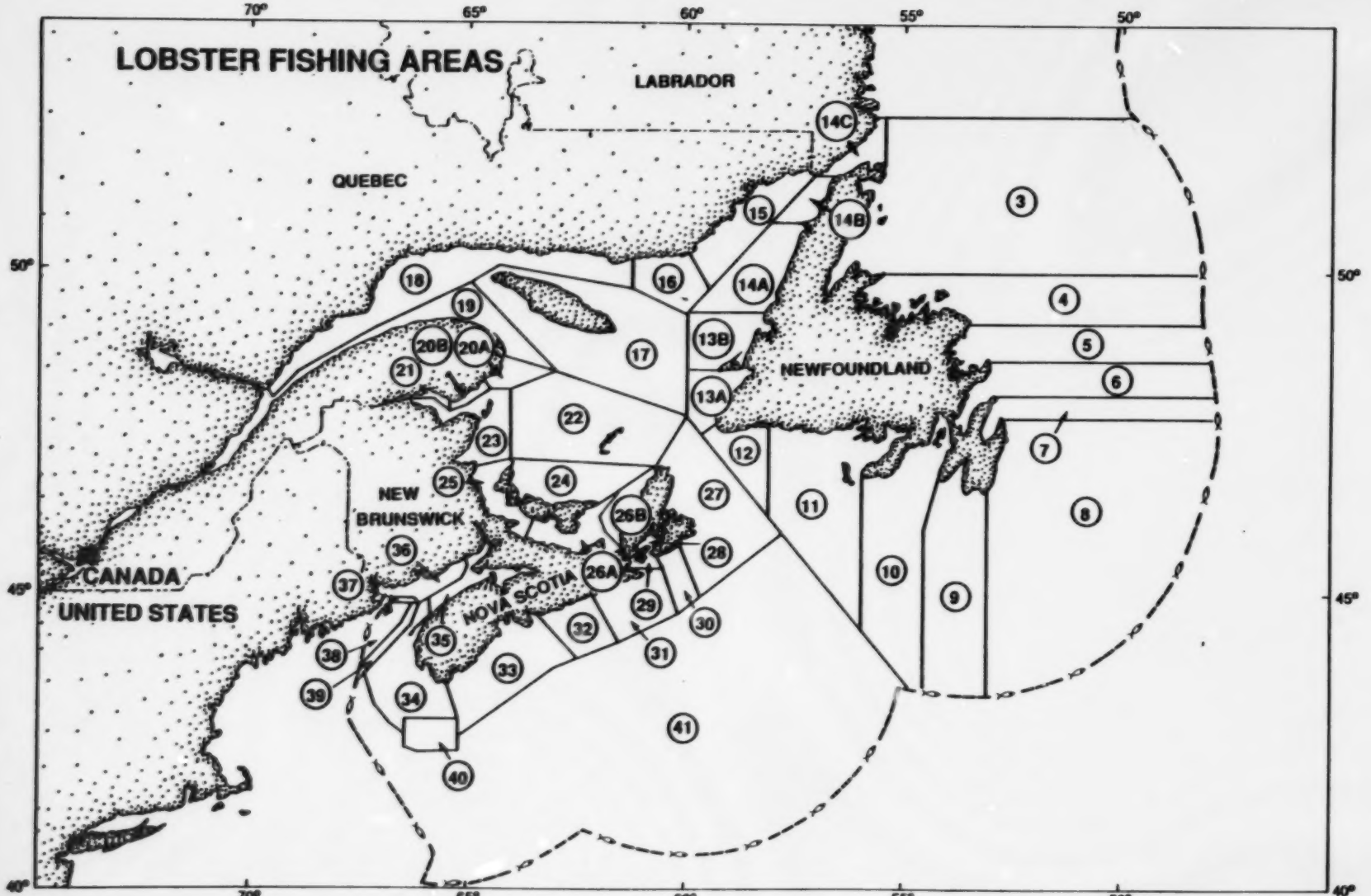



Figure 4. Atlantic provinces Scallop Fishing Areas.

Figure 5. Atlantic Provinces Lobster Fishing Areas.



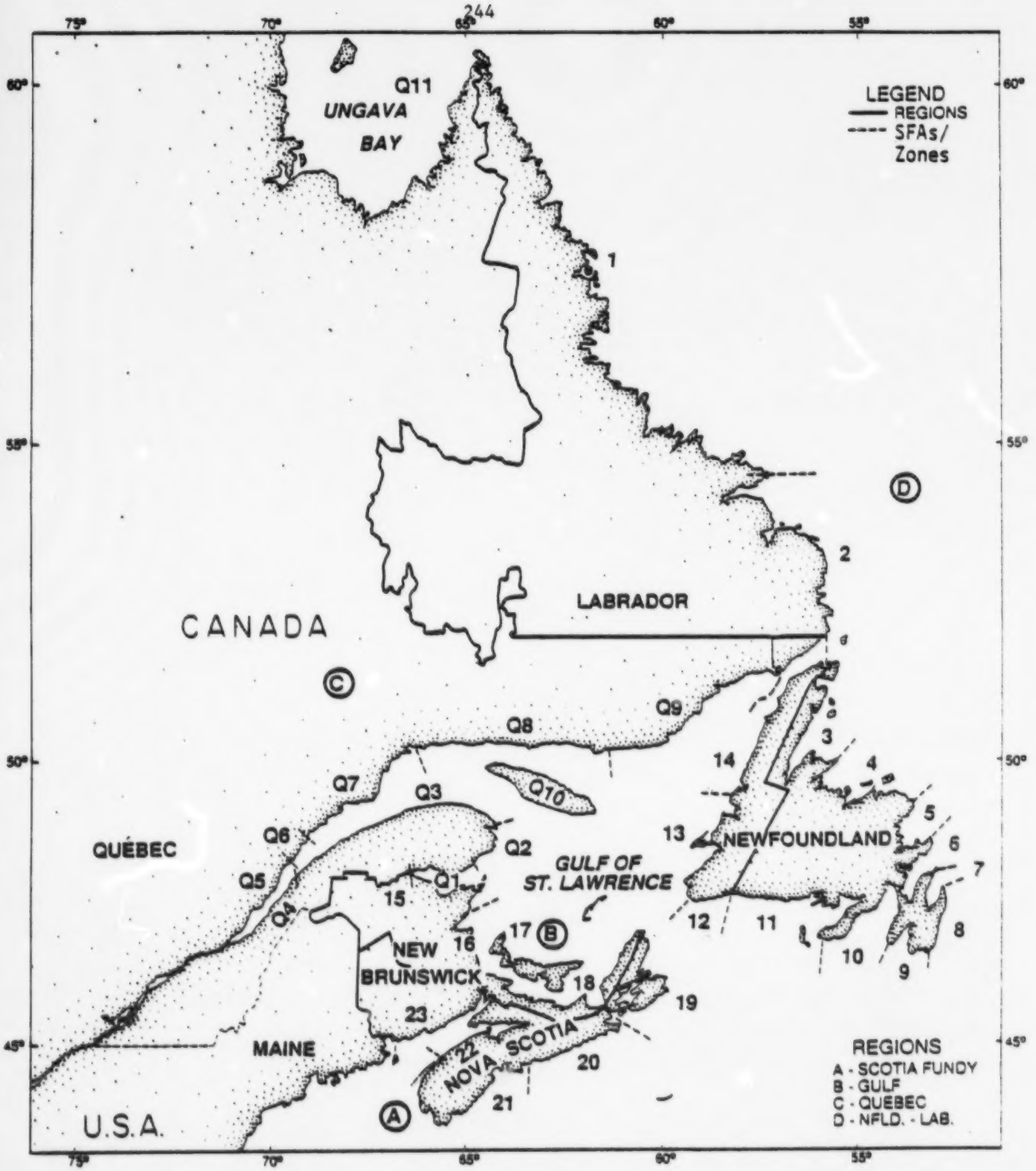



Figure 6. Map of Atlantic Provinces showing Salmon Fishing Areas 1-23, Salmon Management Zones of Quebec (Qs) 1-11, provincial and DFO regional boundaries.

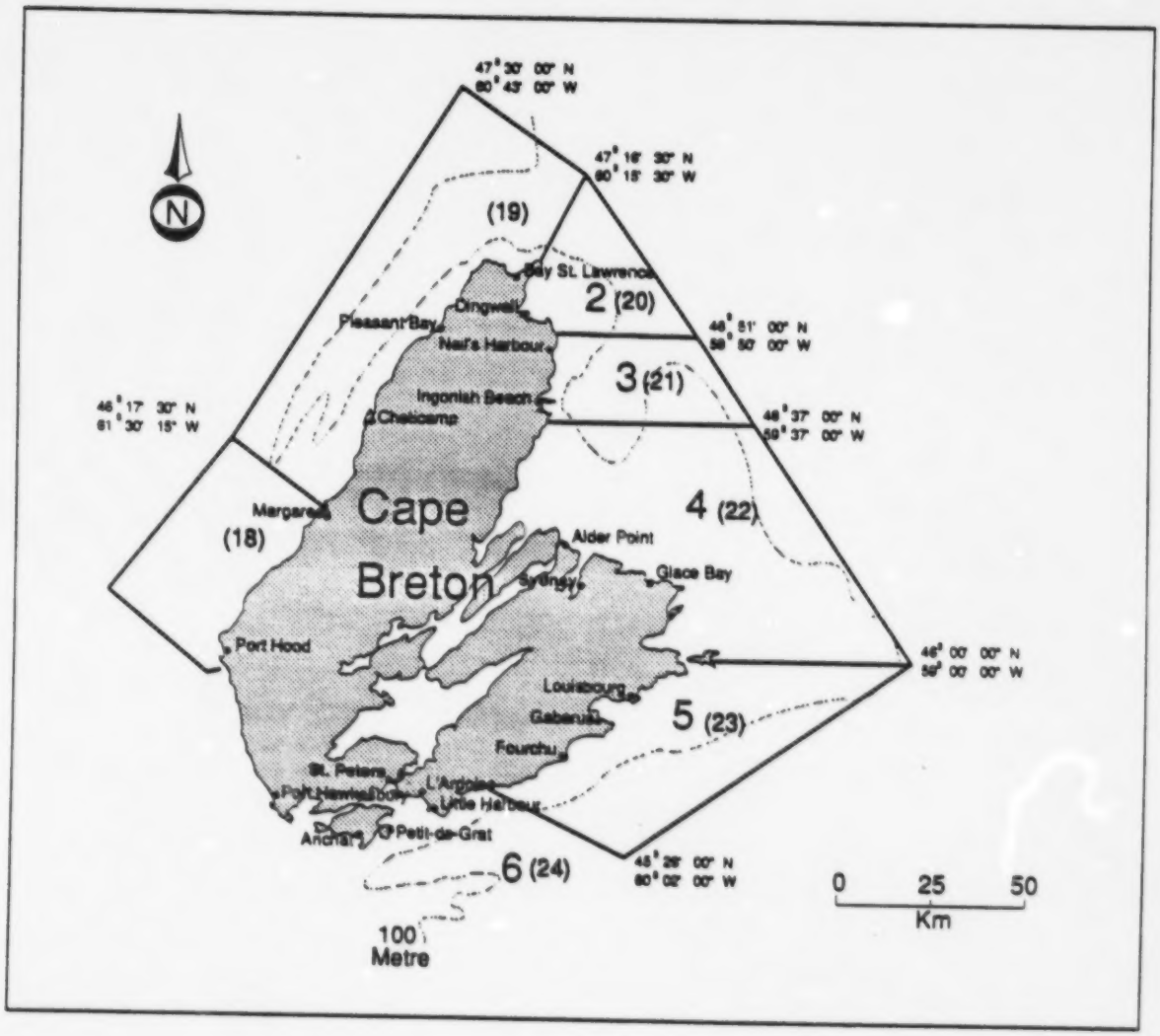



Figure 7. Cape Breton snow crab areas.

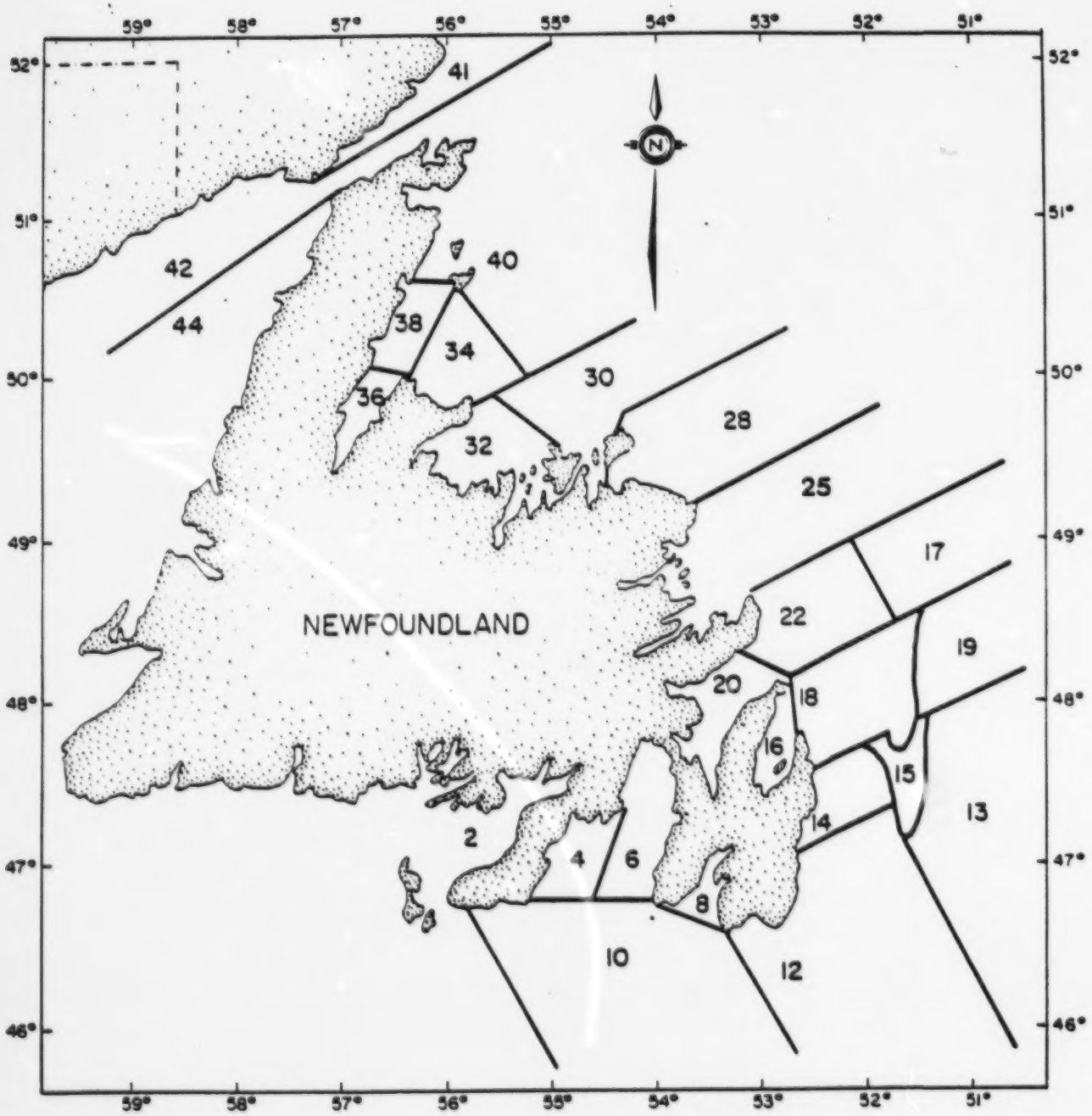



Figure 8. Newfoundland Snow Crab Management Areas (12-25 incl is the southern zone, 28-40 incl. is the northern zone).

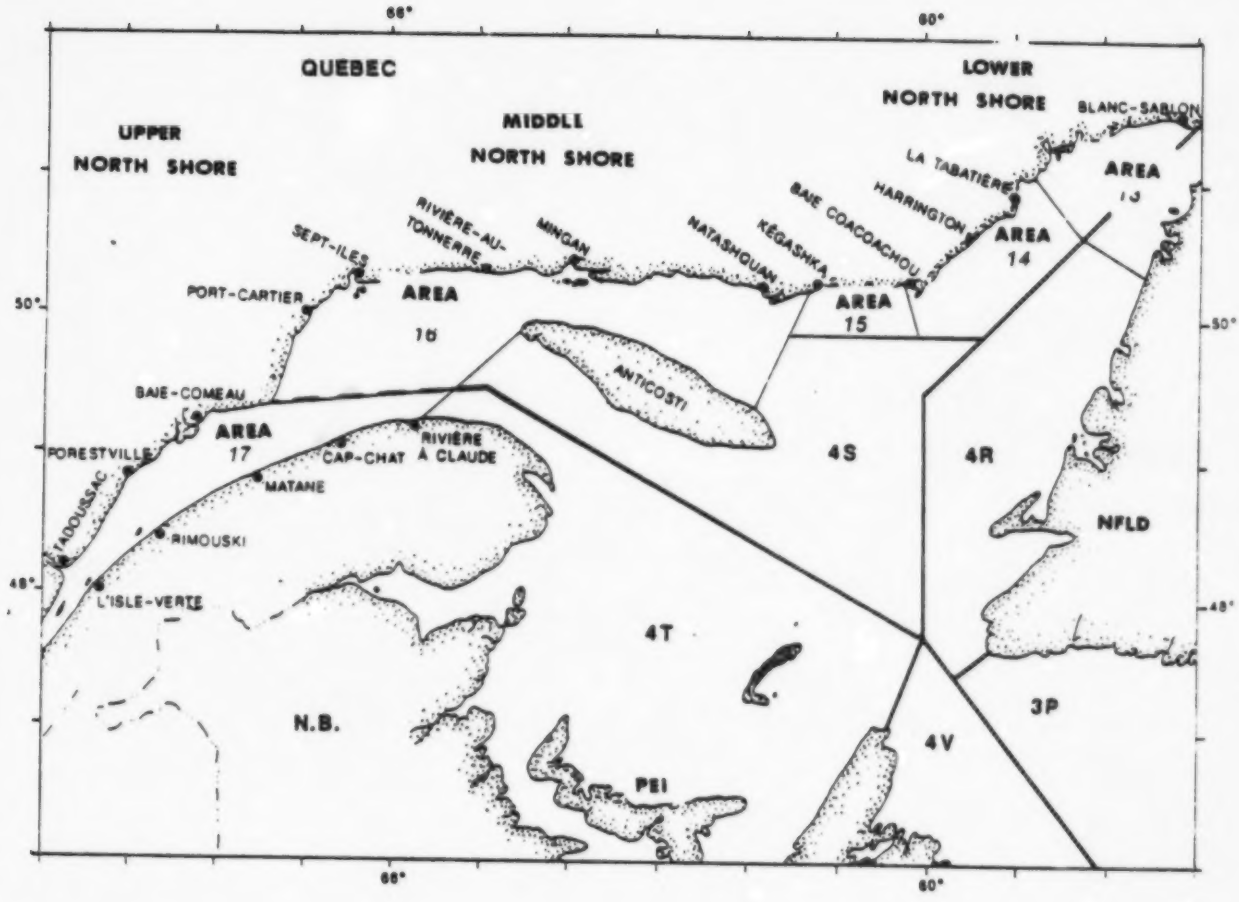



Figure 9. St. Lawrence Estuary Snow Crab Management Areas.

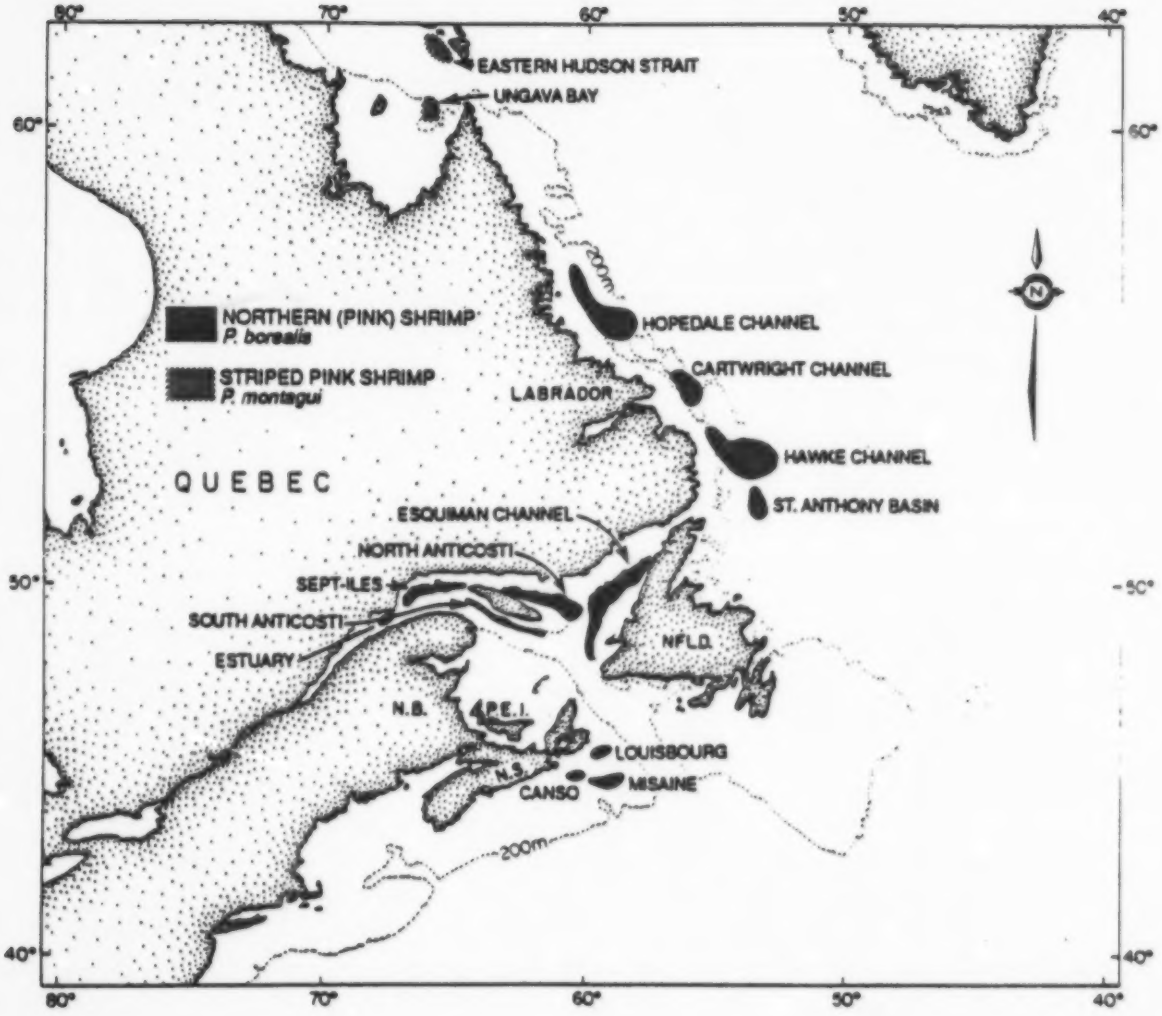



Figure 10. Principal areas of shrimp concentrations.

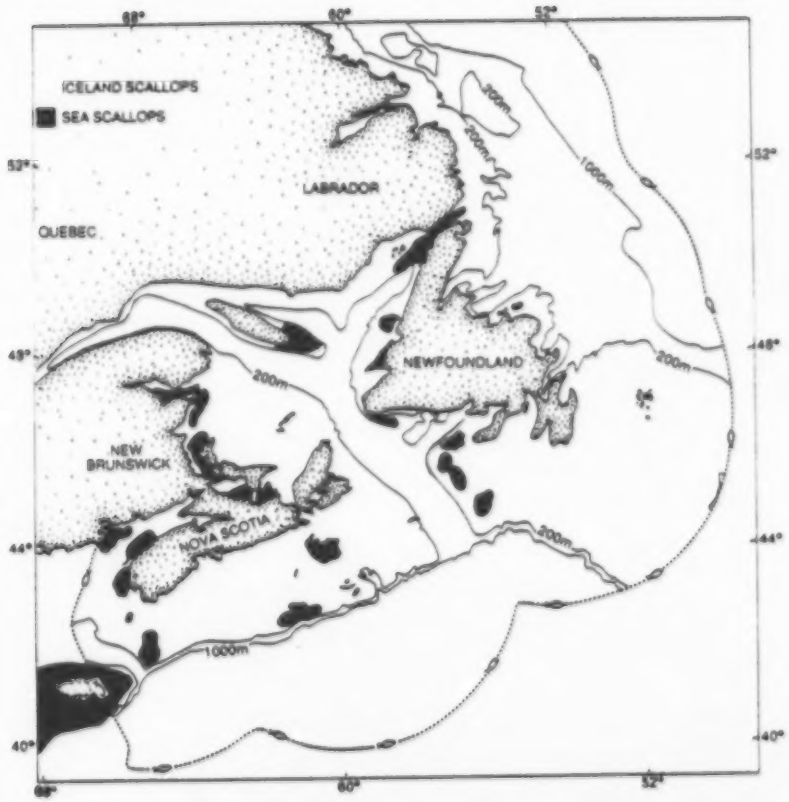



Figure 11. Principal areas of Iceland and Sea scallop concentrations.

## Abbreviations

ACFFS - Anadromous, Catadromous and Freshwater Fishes Subcommittee (CAFSAC)

ADM - Assistant Deputy Minister (Department of Fisheries and Oceans)

Ad. Doc. - Advisory Document (CAFSAC)

AGAC - Atlantic Groundfish Advisory Committee

APECSS - Atlantic Program Economics Coordination and Support System Committee (Department of Fisheries and Oceans)

AS - Autumn spawning herring (also written FS)

Av. - Average (also ave.)

BIO - Bedford Institute of Oceanography

$B_o$ - Unexploited standing stock (virgin biomass)

CL - Carapace length

cm - Centimeters

Comm. - Commercial

COSEWIC - Committee on the Status of Endangered Wildlife in Canada

CPUE - Catch per unit of effort (sometimes CPE or C/E)

DFO - Department of Fisheries and Oceans

Div. - Division

EEC - European Economic Community

$2/3E_{msy}$ - Two thirds of the effort that would be required to take the maximum sustainable yield

Est. - Estimate

F - Instantaneous rate of fishing mortality

FEAC - Fisheries Economic Advisory Committee (Department of Fisheries and Oceans)

$F_{0.1}$ - The instantaneous rate of fishing mortality (calculated from a yield-per-recruit curve) at which a unit increase in fishing effort (proportional to fishing mortality) will give an increase in yield 1/10th that of a unit of effort on the virgin stock (dynamic pool model)

fm - Fathom

$F_{max}$ - The instantaneous rate of fishing mortality which maximizes the yield per recruit (dynamic pool model)

| | |
|---|---|
| $F_{msy}$ | - The instantaneous rate of fishing mortality generated by the fishing effort which gives the maximum sustainable yield (general production model) |
| $F2/3_{msy}$ | - The instantaneous rate of fishing mortality generated by 2/3 of the fishing effort which gives the maximum sustainable yield (general production model) |
| $F_t$ | - "Terminal F", that is, the F in the last, or most recent, year of a sequential population analysis |
| G.M. | - Geometric mean (also written GM) |
| GRT | - Gross registered tons |
| ICCAT | - International Commission for the Conservation of Atlantic Tunas |
| ICES | - International Council for the Exploration of the Seas |
| ICJ | - International Court of Justice |
| ICNAF | - International Commission for the Northwest Atlantic Fisheries (ceased operation at the end of 1979) |
| kg | - Kilogram |
| kg/h/m | - Kilogram/hour/meter (Catch rate in kilograms per hour fished standardized on the basis of meters of dredge width) |
| kg/man/wk | - Kilogram/man/week |
| lb | - Pound (avoirdupois) |
| M | - Instantaneous rate of natural mortality |
| m | - Meters |
| MEES | - Marine Environment and Ecosystems Subcommittee (CAFSAC) |
| mm | - Millimeters |
| MSW | - Multi sea-winter (salmon) |
| MSY | - Maximum sustainable yield |
| mt | - Metric tons also written as t, tons, and tonnes in this report (2204.6 lbs) |
| N/A | - Not available |
| NAFO | - Northwest Atlantic Fisheries Organization |
| NASCO | - North Atlantic Salmon Conservation Organization |
| NST | - Newfoundland Standard Time |
| OTB | - Bottom otter trawl |

| | |
|---|---|
| PR | - Partial recruitment (also written P.R.) |
| QSBD | - Quebec Statistics Bureau Districts (QSB is Quebec provincial agency) |
| q | - Catchability coefficient |
| Rec. | - Recreational |
| Res. Doc. | - Research Document (CAFSAC) |
| RV | - Research vessel |
| SCS. Doc. | - Scientific Council Summary Document (NAFO) |
| SFA | - Salmon fishing areas |
| SPA | - Sequential population analysis is a mathematical technique for estimation of historical stock size and fishing mortality based on removals by the commercial fishery. Virtual population analysis (VPA) and cohort analysis are methods of sequential population analysis |
| Sq. naut. mi. | - Square nautical miles |
| SS | - Spring spawning (herring) |
| SSSS | - Statistics, Sampling and Surveys Subcommittee (CAFSAC) |
| STACRES | - Standing Committee on Research and Statistics (the ICNAF Scientific Committee) |
| STACFIS | - Standing Committee on Fisheries Science (a NAFO Standing Committee) |
| Subdiv. | - Subdivision |
| SWNS | - Southwest Nova Scotia |
| 1SW | - One sea-winter (salmon) |
| TAC | - Total allowable catch |
| TC | - Tonnage class |
| t/hr | - Tonnes/hour |
| VPA | - Virtual population analysis (see SPA) |
| wt | - Weight |
| Y | - Yield |
| Y/R | - Yield per recruit |
| Z | - Instantaneous rate of total mortality |
| ZIFF | - Zonal Interchange Files Format |